NATURAL HISTORY
OF
NOVA SCOTIA

VOLUME ONE

TOPICS AND HABITATS

Parks and Recreation Division
Department of Lands and Forests

and

Nova Scotia Museum
Department of Education

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Natural History of Nova Scotia

Volume One
Topics and Habitats

Prepared for:

Parks and Recreation Division
Department of Lands and Forests

Nova Scotia Museum
Department of Education

Prepared by:

Maritime Resource Management Service Inc.
and Griffiths-Muecke Associates

1984

Nova Scotia
**Province of
Nova Scotia**

**Department of
Lands and Forests**

**Department of
Education**
Nova Scotia Museum

To the Reader:

Nova Scotia is renowned for the scenic beauty and diversity of its natural environment. Its seashore, highlands, interior lakes and forests provide a setting for a lifestyle that is envied across Canada and comprise attractions that draw visitors from afar.

These natural history elements are therefore a fundamental provincial resource. In many ways they are the foundation of our unique quality of life, and the resource upon which our tourism industry is based.

But our natural environment must be understood as a heritage resource, in order to be valued and appreciated and, ultimately, to be properly protected and managed for the benefit of future generations. This Natural History of Nova Scotia represents an important advancement in this process. In so doing, it identifies the Province's natural history elements such as landforms, soils, plants and animals, and describes the natural processes and ecological relationships that link these elements together.

The project has been sponsored jointly by the Department of Lands and Forests and by the Department of Education (Nova Scotia Museum). These departments have direct responsibilities for the conservation and management of natural history resources--Lands and Forests through the Provincial Parks Act, the Beaches Preservation and Protection Act, and the Lands and Forests Act; the Department of Education through the Nova Scotia Museum Act and the recently enacted Special Places Act.

The primary application of the information in Natural History of Nova Scotia will be to assist in the designation and management of Provincial Parks and Special Places. These programs are aimed at protecting and interpreting natural history resources. Beyond these immediate uses, however, a wide variety of additional applications is foreseen. These include environmental education within the Province's school system, land use planning and environmental management, and the general enhancement of the appreciation of Nova Scotia's heritage resources on the part of both residents and tourists.

Through the preparation of this document, the Province of Nova Scotia has established a basic framework within which natural history resources can be identified, evaluated and where appropriate, protected and interpreted. It is our sincere hope and expectation that this important initiative will lead to a greater awareness of the Province's natural heritage values, and serve to stimulate increased efforts to manage and conserve natural history elements of recognized importance.

Terence R. B. Donahoe

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Preface

"Natural history" is a long-standing term originally used by early field researchers to describe their wide range of interests and activities. These researchers, or naturalists, tried to understand the relationships of the natural world while pursuing their detailed studies. Many of them were true ecologists; the Natural History of Nova Scotia takes an ecological or naturalists approach to understanding our environment. It relates the historical evolution of Nova Scotia; geology, landscape development and climatic change with the elements of the present environment; the climate and the ocean, coastline, rivers and lakes, soils, plants and animals.

The idea of natural history regions, first developed in 19th Century descriptive regional geographies of western Europe, has recently been revitalized by parks planners in North America. The term, "natural history theme regions", was introduced to planning for outdoor recreation and preservation in Nova Scotia by G.D. Boggs in a 1976 report to the Department of Lands and Forests. This report suggested a tentative division of Nova Scotia into a number of regions each of which had a distinctive character and could therefore be said to be the expression of one or more natural history themes.

The theme region approach emphasizes those aspects of an area's natural history which are representative rather than those which are rare. It focusses on processes and on interrelationships - how a landscape develops, or why a particular environment supports a particular species. In the phrase which has come to be the key test of relevance, theme regions are concerned with, "the common and the conspicuous".

A considerable body of knowledge has been gained concerning Nova Scotia's natural history. Some of this knowledge was obtained through pioneering scientific field investigations by men such as Dawson, Fernow and Goldthwait whose work is still relevant today. A multitude of theses from the geology, biology and oceanography departments of the province's universities have added to this knowledge. More recently government sponsored research has accelerated the expansion of knowledge and understanding in these subjects. The Natural History of Nova Scotia draws on this fund of knowledge and, although there are acknowledged gaps, has not indulged in any original field research.

A consolidation of much of our knowledge concerning the Province's geological evolution is contained in Dr. Albert Roland's recently published book, "The Geological Background and Physiography of Nova Scotia". Dr. Roland's work has considerably eased the burden of presenting the Natural History of Nova Scotia for the first time.

The three parts of this reference manual describe Nova Scotia's natural history from three perspectives; the natural or theme regions, the elements of the natural environment or topics, and the various habitats. As such "The Natural History of Nova Scotia" is intended to provide a framework within which the significant natural history resources of the province can be understood, protected and interpreted.

The project has been sponsored jointly by the Department of Lands and Forests (Parks and Recreation Division) and by the Department of Education (Nova Scotia Museum). These departments have direct responsibilities for the conservation and management of natural heritage resources - Lands and Forests through the Provincial Parks Act, the Beaches Preservation and Protection Act, and the Lands and Forests Act; the Nova Scotia Museum through the recently enacted Special Places Act.

To fulfill these responsibilities, it is first necessary to identify natural history elements; such as rocks, soils, plants and animals, and to understand associated natural processes and ecological relationships. Their use and management for scientific, educational and outdoor recreation purposes may then be considered.

The primary applications of the project relate to Provincial Parks, Special Places, and environmental education. An initial task will be to evaluate the extent to which existing Provincial Parks protect and interpret significant examples of Nova Scotia's natural history. Similarly the Advisory Committee on Special Places will be able to evaluate candidate ecological reserves and other special places for representativeness or uniqueness in Nova Scotia. Biology and geography teachers can be expected to explore uses for the Natural History of Nova Scotia in both classroom and field studies classes. Beyond these uses a wide variety of applications are anticipated, ranging from environmental and land use planning to the general enhancement of an appreciation of the Province's heritage resources on the part of both Nova Scotians and tourists.

This is seen as an evolving document which will always be incomplete since information is continuously being assembled by many researchers and natural history enthusiasts. Critical comments and new information are welcomed and should be directed to either The Nova Scotia Museum or the Parks and Recreation Division.

While the contract for this work was managed for the Nova Scotia Departments of Education and Lands and Forests by Maritime Resource Management Service the greatest burden of the work was carried by Griffiths-Muecke Associates. Much of the text preparation, arrangement for reviews, arrangements for illustrations and editing of the final document was undertaken by Lesley Griffiths and Anne Muecke. With the immense scope of the subject matter and the difficulty of integrating so much diverse material from so many sources, the successful completion of this report is a testament to their commitment and understanding. The management team thanks them for their efforts.

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Organization of the Natural History

The Natural History of Nova Scotia is divided into three main parts, contained in two volumes:

Volume I contains two main sections; Topics and Habitats.

Volume II contains the Theme Regions descriptions, the Glossary, Bibliography and Index, and a 1:500,000 scale fold-out map.

Topics

In the topics section basic information about the environment of Nova Scotia is organized in the conventional way under headings such as Geology, Currents and Tides, and Surface Water. The topics can be read by themselves, or can be used to enrich the reader's understanding of the Theme Region or Habitat descriptions.

Habitats

A habitat is simply the place where plants or animals live. A wide variety of habitat types in Nova Scotia have been identified and the key ecological features described. Like the Theme Region descriptions, Habitats link the physical and biological elements but at a different scale. In one sense a Habitat corresponds to yet another subdivision within the Hierarchical system of Region, District and Unit, except that the basic features described are not necessarily tied to any particular area of the province.

Theme Regions

Nova Scotia has been divided into nine Theme Regions, which are in turn sub-divided into Districts and then Units.

A Theme Region is an area of distinctive character in which the landscape contains recurring patterns of landform and vegetation, which have developed through the combination of many physical and biological factors. The Theme Region approach seeks to integrate the different elements of natural history, so often studied in isolation - the climate, geology, landform, coastal regime, soils, water characteristics, plants and animals. It also enables us to explore and interpret the geological diversity of Nova Scotia.

How to Use the Natural History

IF YOU ARE INTERESTED IN A PARTICULAR SUBJECT ..... Refer to the Table of Contents in Volume I and find the relevant Topic. Alternatively you may use the Index and refer to a specific page. The Topic sections also make reference to other related Topics and Habitats and to additional resources in the Bibliography.

IF YOU ARE INTERESTED IN A PARTICULAR HABITAT ..... Consult the Table of Contents in Volume I and identify the most appropriate Habitat. Habitats are grouped by a simple classification scheme into Coastal, Freshwater, Terrestrial Unforested, Terrestrial Forested and Man-made Habitats. You may also find it useful to start with the Introduction to the Habitat section on p. 305. The Habitat descriptions contain references to other Topics and Habitats and to additional information sources.

IF YOU ARE INTERESTED IN A PARTICULAR AREA OF NOVA SCOTIA.....
Start with Volume II: Theme Regions. From the fold-out map identify the Region, District or Unit which includes the area you wish to study. Remember that the classification system is hierarchical (more about this in the following section). If you are interested in a specific Unit, you should start with the Region and then the District of which it is a part in order to find the maximum amount of information. At the end of the description you may be referred to related Topics or Habitats which you will find in Volume I.

The Region description provides a general overview. The District description addresses just those aspects which the different Units within the District have in common, and may be very brief. The most detailed information will usually be found under the Unit heading. However, because some areas have been less studied than others the amount of information varies.

Place Names

Many references to specific places are made in both volumes. Not all of them will be found on the Theme Regions map in Volume I. For complete coverage, and to locate a place name, use:

Index of Geographical Names for the Map of the Province of Nova Scotia

in conjunction with

A Map of the Province of Nova Scotia (booklet form, published in 1979)

Both may be purchased at the Government Bookstore.

Visiting Sites of Special Interest

It must be emphasized that the mention of any specific locality in the Natural History does not neccessarily mean that it is accessible to the public. For example, many of the IBP sites (sites proposed for inclusion in the International Biological Programme) are in private ownership. Before planning a trip always check first to see if permission to enter is required.

Field Guides

The Natural History of Nova Scotia is intended to provide an overview. To identify specific plants, animals or natural materials you will need to use field guides. The popular and easily obtainable field guide series, listed below, cover a wide range of geological, botanical and zoological subjects relevant to Nova Scotia. More detailed treatments are mentioned in the topic sections and listed in the references.

*Golden Nature Guides, Golden Press, New York.

*The Peterson Field Guide Series, Houghton Mifflin Company, Boston.

*The Audubon Society Field Guides, Alfred A. Knopf, New York.

*The Pictured-key Nature Series ("How to Know" books) Wm. C. Brown Company Publishers, Dubuque, Iowa.

T1 Canadian Setting

Nova Scotia has a diversity of landscape and habitat packed into 21,000 square miles (55,000 km^2), which is not found in many areas of comparable size in Canada. It is interesting to think of Nova Scotia as a kind of crossroads, where two ancient continents met millions of years ago; where now continent and ocean meet; and where the southerly climatic and forest region makes the transition into the northerly boreal zone.

The meeting of continent and ocean has many implications. In terms of geological processes the continental margin is where evidence of crustal movements is most obvious. As the plates of the lithosphere slide past each other, the resulting pressures show up in folding, faulting, uplift, submergence and the extrusion of igneous rock. This marginal activity has made a substantial contribution to the wide variety of rock formations in Nova Scotia.

The meeting of land and water, maximized by Nova Scotia's long and convoluted coastline, also results in a variety of environments which are physically dynamic, and biologically productive. The coastal waters are influenced by both the cold Labrador Current and the warm Gulf Stream.

Finally, the province lies between the milder climatic region of the southern United States and the harsher boreal region of the Canadian north. The transitional nature of the region is reflected in a wide variety of forest associations and in the intermingling of plants and animals with very northerly ranges with those that can be found in Louisiana or Carolina.

Geology

Nova Scotia developed through the incremental additions of other land masses, first the Avalon and then the Meguma Zones, to the northeast margin of the ancient North American continent. This was followed by a long period during which Nova Scotia was in the middle of a vast

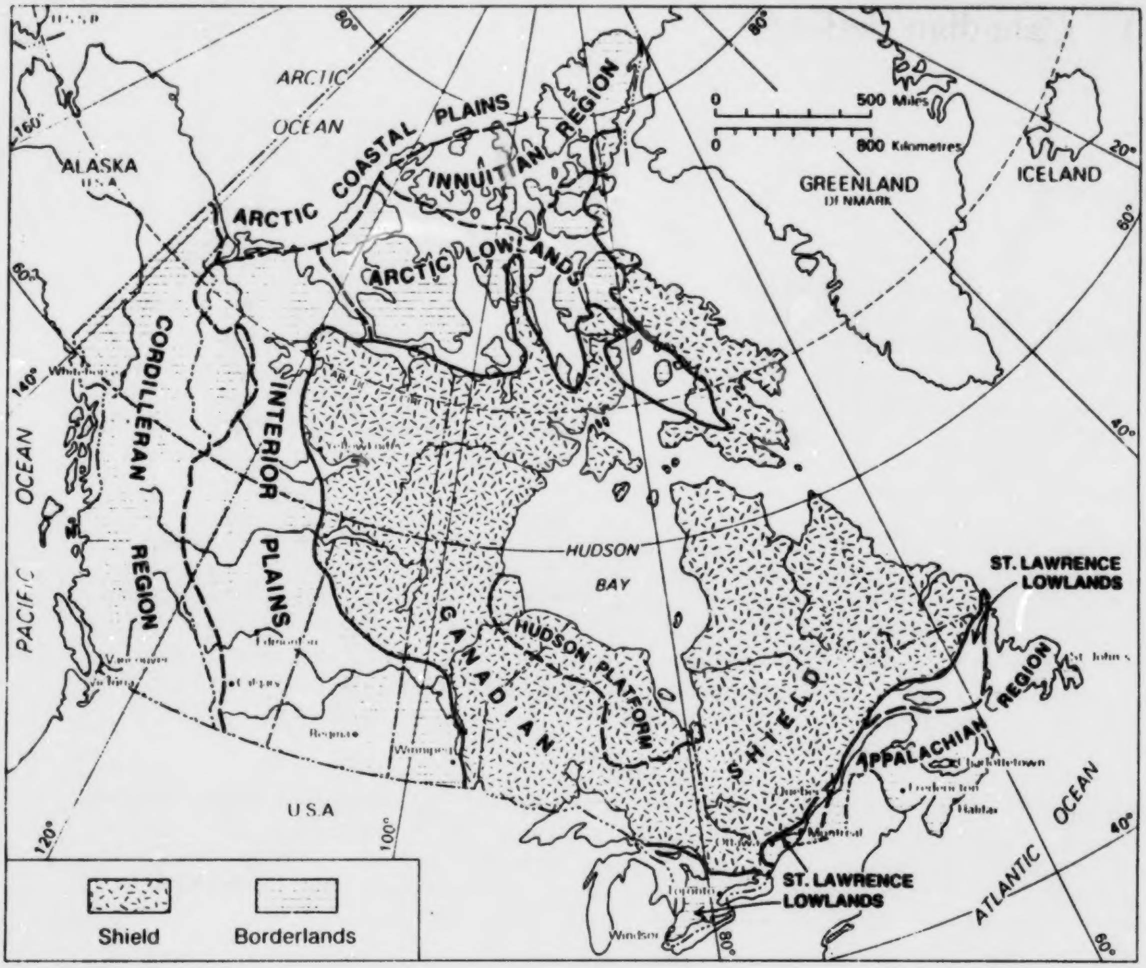

U.S.S.R.
ARCTIC OCEAN
ARCTIC COASTAL PLAINS
INNUITIAN REGION
ARCTIC LOWLANDS
0
500 Miles
0
800 Kilometres
ALASKA U.S.A.
GREENLAND DENMARK
ICELAND
CORDILLERAN REGION
INTERIOR PLAINS
PACIFIC OCEAN
Whitehorse
Yellowknife
Edmonton
Calgary
Vancouver
Victoria
Regina
Winnipeg
HUDSON BAY
HUDSON PLATFORM
CANADIAN SHIELD
ST. LAWRENCE LOWLANDS
APPALACHIAN REGION
St. John's
Charlottetown
Fredericton
Halifax
Quebec
Montreal
Ottawa
Toronto
Windsor
ATLANTIC OCEAN
USA
80°
160°
60°
140°
120°
100°
80°
20°
60°
40°
40°
60°
Shield
Borderlands

Fig. 1. Physiographic Regions of Canada.
Agriculture Canada (1977)

continental mass, and partly included in a large sedimentary basin. This supercontinent then rifted along what is now the continental shelf. The eastern edge of North America continues to grow but in a more passive way, as sediments from continued erosion of the land are deposited on the shelf and in deeper waters beyond.

Physiography

Physiographically Nova Scotia is part of the Appalachian Region, which in turn is part of the Borderlands which form a crescent around the great Precambrian Shield (Figure 1). The Shield is a giant core of old, massive, crystalline rocks. Around it the Borderlands form two concentric rings of younger, mainly stratified rocks. The inner ring consists of lowlands, plains and plateaus of generally flat-lying sedimentary rocks, while the outer ring, of which the Appalachian Region is part, is formed of discontinuous areas of mountains and uplands.

The Appalachian Region (Figure 2) includes all of the Atlantic Provinces, the Gaspé peninsula and Eastern Townships of Quebec, the Green Mountains in Vermont, the White Mountains of New Hampshire and Maine and the New England uplands. The physiography of the Region is dominated by a well-developed peneplain, probably of Cretaceous age, which is generally highest in the northwest, sloping gently southeastwards towards the ocean. The differential erosion of soft and hard rocks have formed lowlands, highlands and uplands. This old erosion surface is evident in the highlands and uplands of Nova Scotia, sloping downward towards the Atlantic. The highlands and uplands of the Appalachian Region surround a lowland plain which has been almost entirely drowned to form the Gulf of St. Lawrence. The Maritime Plain, bordering the Northumberland Strait, forms part of these lowlands.

Glaciation

Like most of Canada, Nova Scotia was glaciated, but its glacial history differs to a certain extent because it was at the edge of the glacial sheet. In the last stages frequent glacial fluctuations, and the movements of local ice caps, scraped up considerable quantities of glacial debris from the underlying rocks,

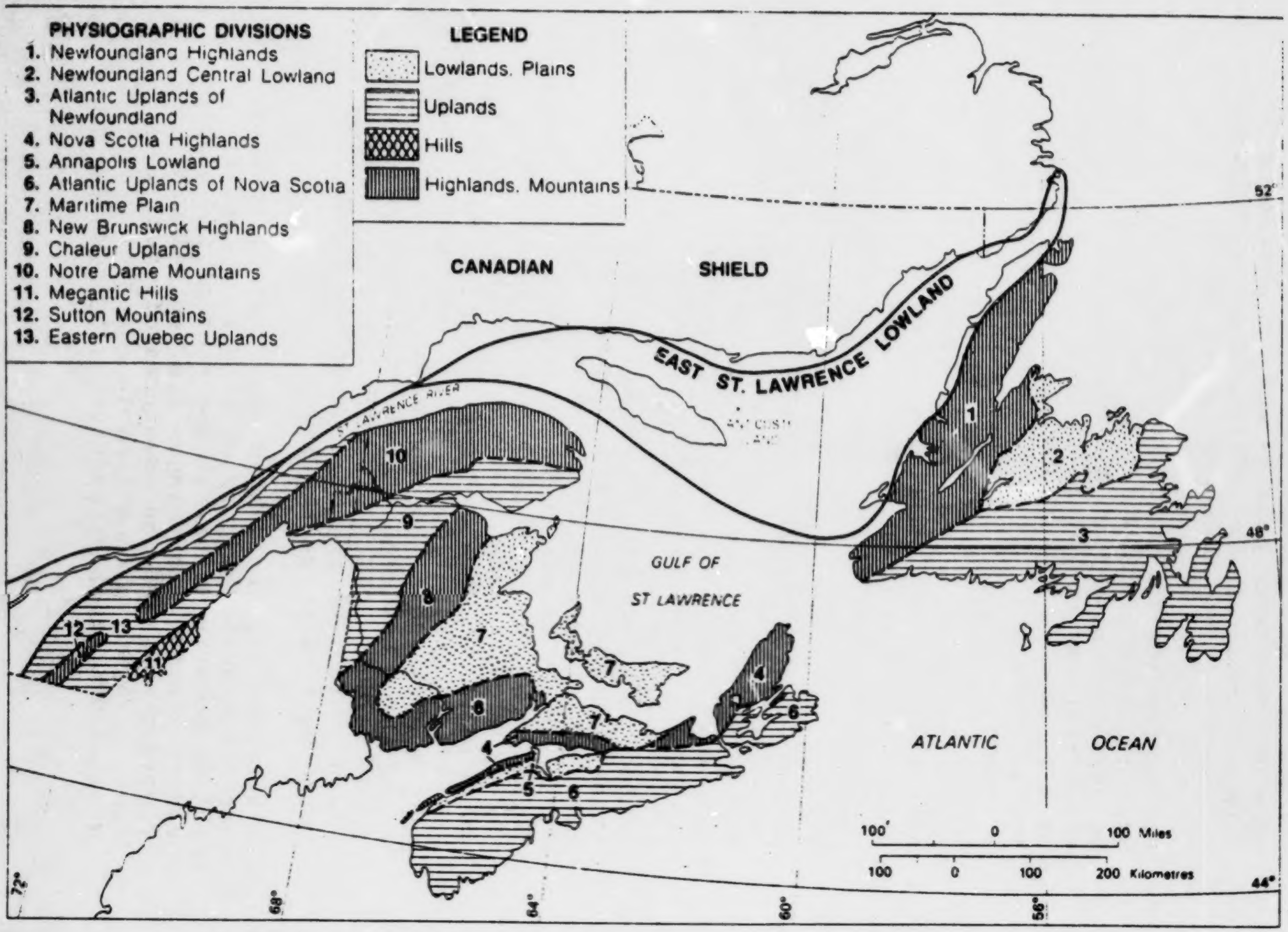

PHYSIOGRAPHIC DIVISIONS
1. Newfoundland Highlands
2. Newfoundland Central Lowland
3. Atlantic Uplands of Newfoundland
4. Nova Scotia Highlands
5. Annapolis Lowland
6. Atlantic Uplands of Nova Scotia
7. Maritime Plain
8. New Brunswick Highlands
9. Chaleur Uplands
10. Notre Dame Mountains
11. Megantic Hills
12. Sutton Mountains
13. Eastern Quebec Uplands
LEGEND
Lowlands, Plains
Uplands
Hills
Highlands, Mountains
CANADIAN
SHIELD
EAST ST. LAWRENCE LOWLAND
ST. LAWRENCE RIVER
GULF OF
ST LAWRENCE
ATLANTIC
OCEAN
100 0 100 Miles
100 0 100 200 Kilometres
52°
48°
44°
72°
68°
64°
60°
56°

Fig. 2. Physiographic Divisions of the Appalachian Region. Agriculture Canada (1977)

without transporting it elsewhere. This debris was then moulded or deposited in a variety of morainal and fluvial land forms.

Climate

Nova Scotia's climate again reflects the meeting of continent and ocean. Its position between 43 and 47 degrees north latitude ensures a marked difference between seasons in insolation and temperature. This difference is accentuated by the continental influence but tempered by the marine influence. Because the dominant sweep of the winds across North America is eastwards Nova Scotia's climate exhibits more of a continental climate than is found on Canada's Pacific Coast. However, the modifying effects of the surrounding waters make winters milder and summers cooler than those experienced in the centre of the country.

The Atlantic Region experiences changeable weather and ample precipitation, resulting from the shifting positions of the three major air masses that abut over the region, and from the frequent passage of eastward moving low pressure cells. This produces a high incidence of cloud and fog and places Nova Scotia in the perhumid and humid moisture regions along with other Atlantic provinces and much of Quebec.

Soils

The predominant soil forming process in the Appalachian Region is podzolization (Figure 3). This process occurs where high precipitation in a cool climate works on coarse glacial deposits under mixed or coniferous forest cover. The result is strongly leached soils with high surface acidity. Podzolic soil types occur in a broad belt along the edge of the Precambrian Shield as far west as Alberta. The Appalachian Region soils differ mainly in the intricacy of the soil mosaic, which reflects the varied textures of the bedrock as well as the complex glacial deposits.

Forests

Nova Scotia is part of the Acadian Forest which lies within the Southern Mixed Forest Region (Figure 4). This is a transitional area between the coniferous Boreal Region to the north and the Deciduous Region to the south. The transitional nature results in a variety of

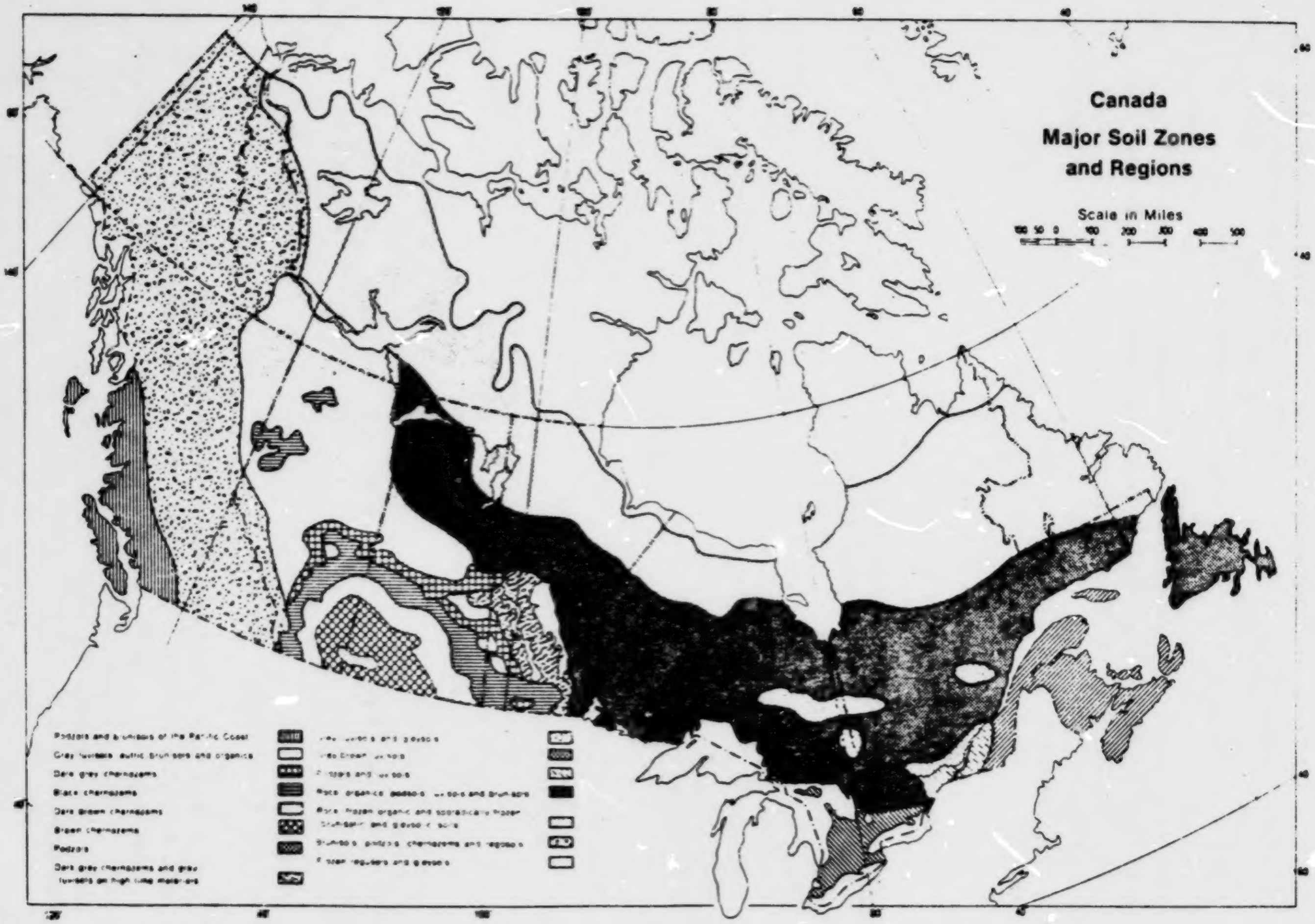

Canada
Major Soil Zones
and Regions
Scale in Miles
100 50 0 100 200 300 400 500
Podzols and brunisols of the Pacific Coast
Grey luvisols, dystric brunisols and organics
Dark grey chernozems
Black chernozems
Dark brown chernozems
Brown chernozems
Podzols
Dark grey chernozems and grey luvisols on high lime materials
Grey luvisols and gleysols
Grey brown luvisols
Podzols and luvisols
Rock, organics, podzols, luvisols and brunisols
Rock, frozen organic and sporadically frozen brunisolic and gleysolic soils
Brunisols, podzols, chernozems and regosols
Frozen regosols and gleysols

Fig. 3. Major Soil Zones and Regions of Canada.
Rowe, J.S. (1972)

different forest associations. Red Spruce, Balsam Fir, Yellow Birch and Sugar Maple are characteristic of the Southern Mixed Region, with lesser numbers of Red Pine, White Pine and Hemlock. The Boreal element, particularly evident in the highlands of Cape Breton, is marked by Black Spruce, Balsam Fir, White Spruce, Poplar and Birch. Coastal exposure is a modifying factor, resulting in a "fog belt" of coastal forest, mostly spruce and fir. As one of the earliest settled areas Nova Scotia's forests have been intensively lumbered. This, together with the abandonent of much former crop and pasture land and the influence of fire, has contributed to the development of a wide range of successional forest types.

Fauna

Although the main part of the fauna is Boreal in character, the post glacial history of Nova Scotia allowed colonization by both sub-arctic species, now seen only as relicts, and later by warm temperate species from the south. The present climatic conditions have not allowed a full development of any of these groups of animals with the results that species diversity tends to be less than experienced further to the west or south.

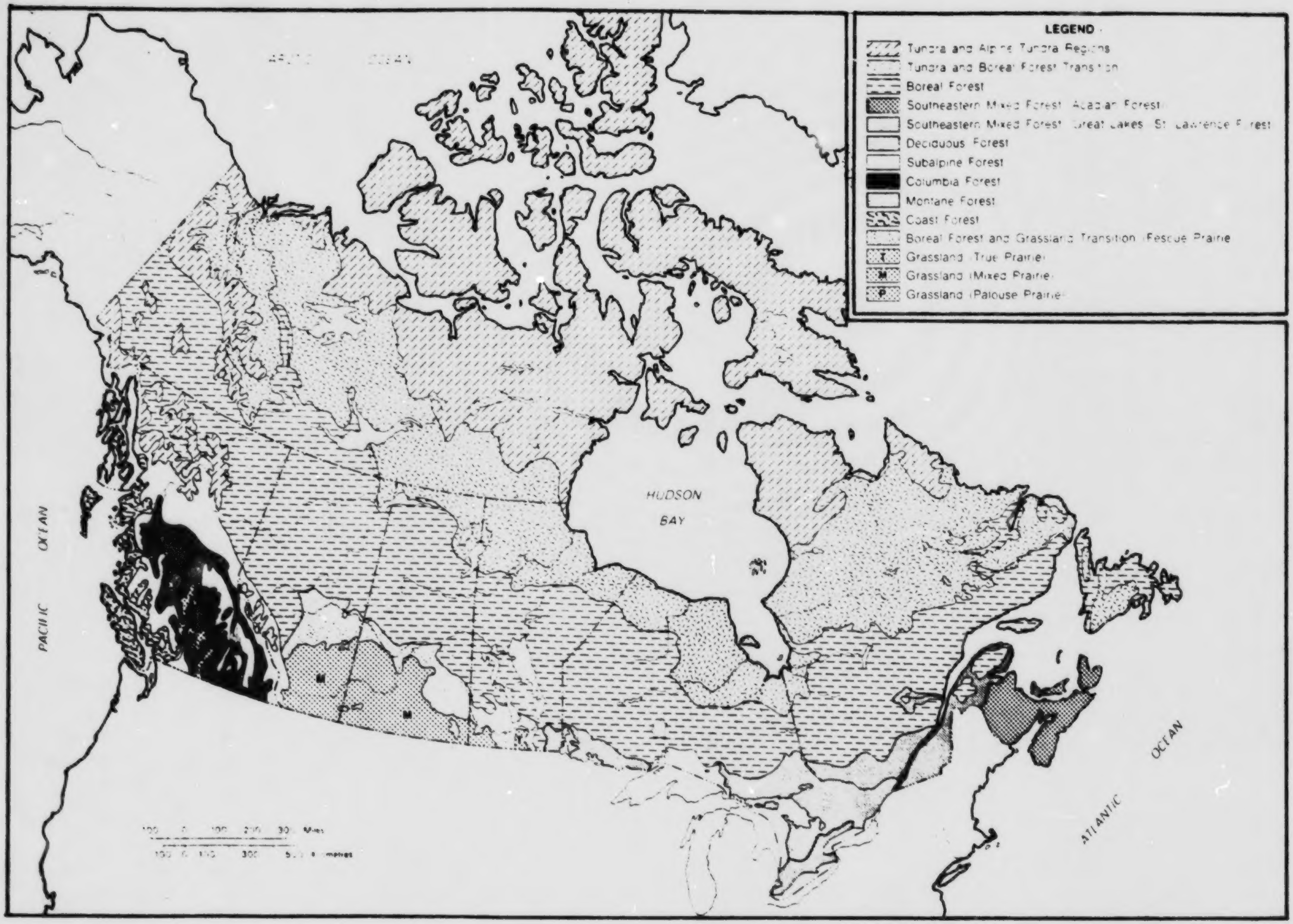

LEGEND
Tundra and Alpine Tundra Regions
Tundra and Boreal Forest Transition
Boreal Forest
Southeastern Mixed Forest (Acadian Forest)
Southeastern Mixed Forest (Great Lakes - St. Lawrence Forest)
Deciduous Forest
Subalpine Forest
Columbia Forest
Montane Forest
Coast Forest
Boreal Forest and Grassland Transition (Fescue Prairie)
T Grassland (True Prairie)
M Grassland (Mixed Prairie)
P Grassland (Palouse Prairie)
ARCTIC OCEAN
HUDSON BAY
PACIFIC OCEAN
ATLANTIC OCEAN
M
M
100 0 100 200 300 Miles
100 0 100 300 500 Kilometres

Fig. 4. Vegetation Regions of Canada.
Rowe, J.S. (1972)

GEOLOGY

T2 Introduction to the Geological History of Nova Scotia

Most of the rock material in the continental areas of the Earth's crust has probably been in existence since the earliest geological times. Since then it has been reworked continuously in the cycle of erosion, deposition, burial, uplift, alteration, exposure, erosion...

It is a fundamental assumption in geology that the forces seen at work today have operated in the same way throughout geological time. Thus the environments created today through the action of wind, water, and ice in various climates can be correlated with those existing in the past.

As evidence is compiled, and paleoenvironments are reconstructed, a sequence of pictures is developed which describe how the strata have been built up, piling one unit upon another. It shows when the climate changed, which areas were connected to each other, where seas and lakes were, how shorelines changed, when and where mountains formed and faults developed.

Even a cursory glance at the geological record shows that movement within and between large bodies of rock has been an integral part of their evolution. This movement has been upwards as mountains rose, downwards as sea covered the landscape, and lateral as sediments were compressed into folds. The presence of fossil tropical species is evidence of the north-south movement of crustal blocks towards or away from the equator.

To understand the causes and pattern of this movement the theory of crustal movement called 'Plate Tectonics' has been used. The basic tenets of this theory - which is still being developed - have been derived from the observation of present day phenomena within the Earth's crust. The most pertinent aspects of the theory will now be reviewed and used later in T3 The Formation of the Appalachian Region and the North Atlantic Ocean to describe the global context within which Nova Scotia developed.

CRUSTAL PLATE MOVEMENT

According to the plate tectonic theory the Earth's crust is composed of a number of moderately rigid plates which move side by side like conveyor belts sliding over a partially molten, plastic layer in the underlying upper mantle (see Figure 5). The plates and their relative directions of motion are shown in Figure 6. By examining the margins of adjacent plates three different types can be defined. Each plate has a particular combination of margin types reflecting its position vis-a-vis other plates and the nature of the movement along the contact:

Spreading Margin	The line along which plates separate and move apart is called the spreading margin. In the process of separation, molten rock (basaltic magma) wells up along linear tensional fractures, solidifies and creates a band of new crust. As each band forms it is moved sideways on the diverging plates and is replaced by a new band. The Mid-Atlantic Ridge is an example of a spreading margin and was once adjacent to Nova Scotia at the edge of the continental shelf. The strip of ocean floor that separates it from the shelf today has been added during the last 180 million years.
Collision Margin	When two plates converge a margin of collision or crustal destruction is formed. At a collision margin the crust and overlying sediments buckle and fold. If both plates have continents at their leading edges high mountain ranges are formed with granites intruded into their cores. If only one plate carries a continent it tends to override the other. The second plate is then pushed downwards and subducted into the Earth's mantle where it is melted and resorbed. Margins of this kind have deep sea trenches along the contact line with a parallel arc of volcanic islands a few hundred kilometers away on the continental plate. It has been suggested that evidence of both types of destructive margin can be seen in Nova Scotia's geological record.
Fault Margin	Long faults are formed in three main locations with respect to crustal plates: - along plate margins where the crustal blocks merely slide past one another (transform faults)

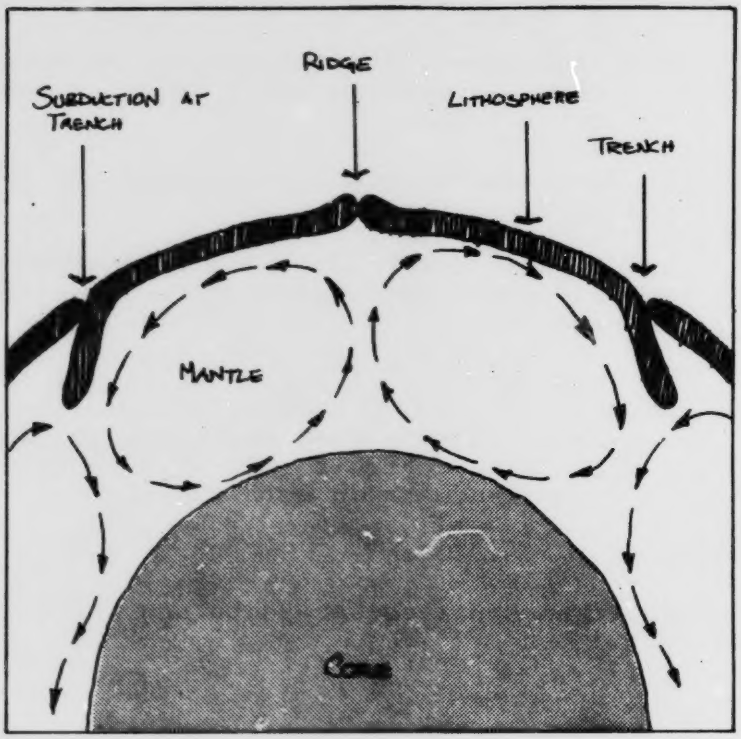

SUBDUCTION AT TRENCH
RIDGE
LITHOSPHERE
TRENCH
MANTLE
CORE

Fig. 5. Generalized Crustal Plate Movement.
Press and Siever (1978)

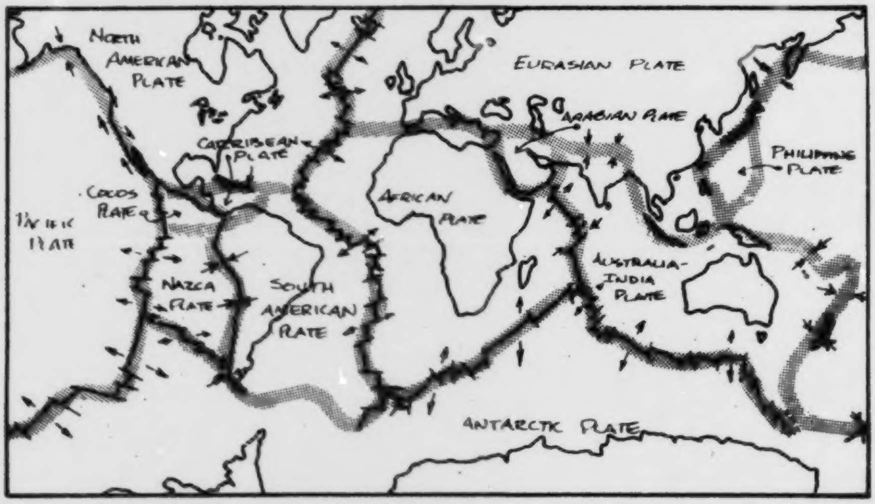

NORTH AMERICAN PLATE
EURASIAN PLATE
ARABIAN PLATE
CARRIBEAN PLATE
PHILIPPINE PLATE
COCOS PLATE
PACIFIC PLATE
AFRICAN PLATE
NAZCA PLATE
SOUTH AMERICAN PLATE
AUSTRALIA-INDIA PLATE
ANTARCTIC PLATE

Fig. 6. Major Crustal Plates. Bloom, A.C. (1969)

- within plates where one part is moving faster than its neighbour (transcurrent faults)
- along the line of an incipient spreading margin where the crust is under tension (rift faults)

In Nova Scotia both transcurrent and rift faults are present.

In T3 a plate tectonics interpretation of Nova Scotia's geological history is presented. This has been developed during the past ten years but is incomplete and controversial. This interpretation will undoubtedly need to be amended in time. It is written in the form of a summary to provide a framework for subsequent topics which cover individual events and paleoenvironments in more detail.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean.

REFERENCES

Press and Siever (1978)

T3 The Formation of the Appalachian Region and the North Atlantic Ocean

Geologically, the history of Nova Scotia is tied in with the formation of both the Appalachian region of eastern North America and the North Atlantic Ocean. This history is complex and incomplete in detail but is broadly made up of four parts.

1. Addition of geological zones to eastern North America.
2. The formation of the 'supercontinent' Pangea
3. Nova Scotia within the continental landmass
4. The breakup of Pangea and forming of the present Atlantic Ocean.

Figure 7 provides a summary of the major events in the geological development of Nova Scotia and should be used as a reference timescale both in this introduction and in subsequent topics .

PART ONE: THE ADDITION OF GEOLOGICAL ZONES TO EASTERN NORTH AMERICA

Paleogeography The early part of the geological history of eastern North America is complex. Several zones of geological material were added, each with a distinctive set of characteristics. Up until Devonian time three zones had been accreted - the Dunnage, Gander and Avalon Zones. These can be correlated at various points from the southern United States northward to Newfoundland and are part of the Appalachian fold belt (see fig. 8).

The mechanism by which these zones were added is unclear. Various models have been put forward but the complexity of geological relationship and incomplete information makes each one inconclusive. A plate tectonic model has been developed for the addition of the Avalon Zone which describes these rocks as being crustal chips within an ocean on one side of which lay ancient North America. Closing of the ocean brought the crustal chips into contact with the continental margin in a collision. This collision may be recorded in the geological record as the folding and metamorphism of the Taconic Orogeny during the Ordovician period (see fig. 7).

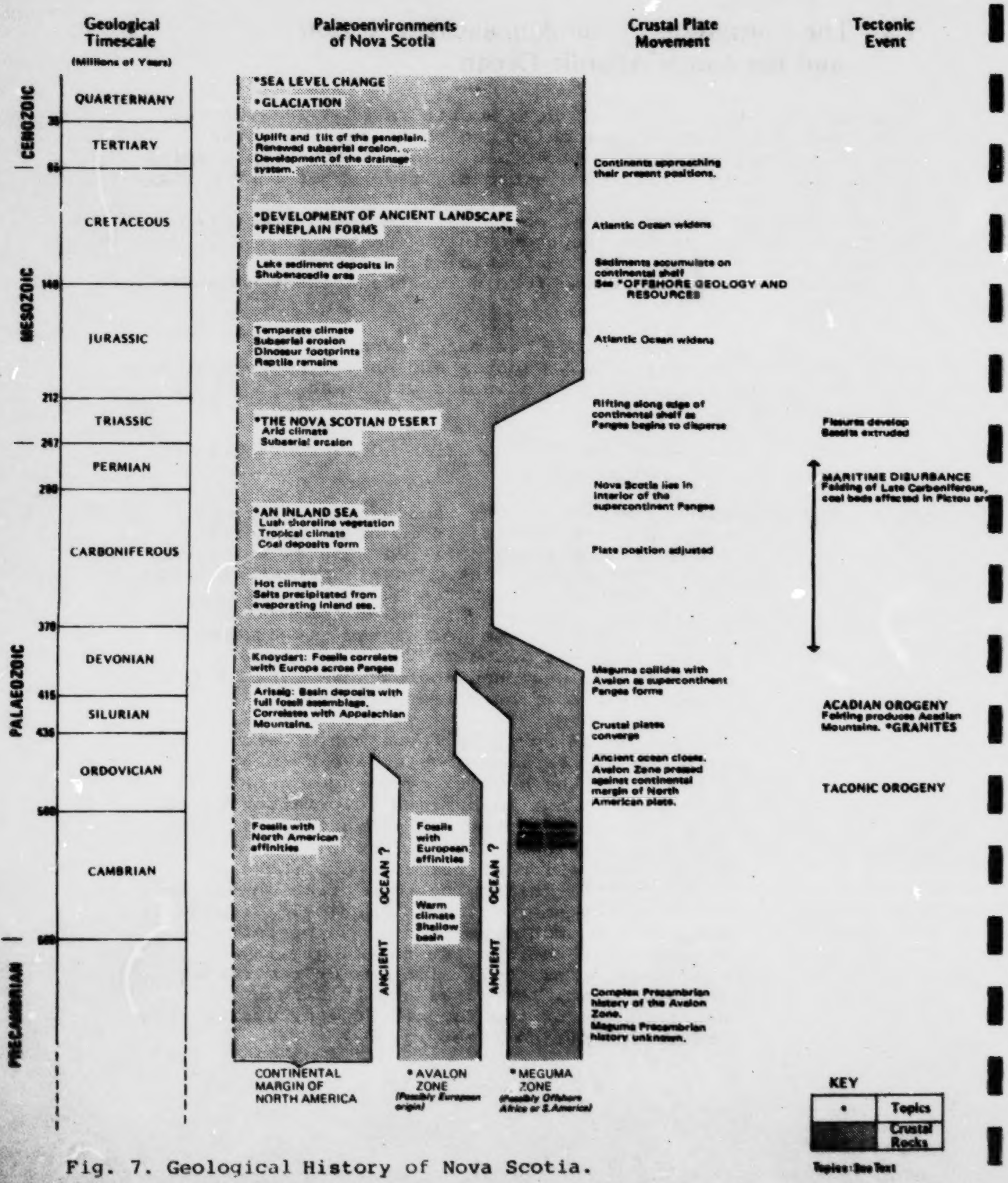

Geological Timescale
(Millions of Years)
Palaeoenvironments of Nova Scotia
Crustal Plate Movement
Tectonic Event
CENOZOIC
MESOZOIC
PALAEOZOIC
PRECAMBRIAN
QUARTERNANY
TERTIARY
CRETACEOUS
JURASSIC
TRIASSIC
PERMIAN
CARBONIFEROUS
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
65
140
212
247
290
370
415
436
500
600
*SEA LEVEL CHANGE
*GLACIATION
Uplift and tilt of the peneplain. Renewed subaerial erosion. Development of the drainage system.
*DEVELOPMENT OF ANCIENT LANDSCAPE
*PENEPLAIN FORMS
Lake sediment deposits in Shubenacadie area
Temperate climate
Subaerial erosion
Dinosaur footprints
Reptile remains
*THE NOVA SCOTIAN DESERT
Arid climate
Subaerial erosion
*AN INLAND SEA
Lush shoreline vegetation
Tropical climate
Coal deposits form
Hot climate
Salts precipitated from evaporating inland sea.
Knoydart: Fossils correlate with Europe across Pangea
Arisaig: Basin deposits with full fossil assemblage. Correlates with Appalachian Mountains.
Fossils with North American affinities
ANCIENT OCEAN ?
Fossils with European affinities
Warm climate
Shallow basin
ANCIENT OCEAN ?
[redacted]
CONTINENTAL MARGIN OF NORTH AMERICA
* AVALON ZONE
(Possibly European origin)
* MEGUMA ZONE
(Possibly Offshore Africa or S.America)
Continents approaching their present positions.
Atlantic Ocean widens
Sediments accumulate on continental shelf
See *OFFSHORE GEOLOGY AND RESOURCES
Atlantic Ocean widens
Rifting along edge of continental shelf as Pangea begins to disperse
Nova Scotia lies in interior of the supercontinent Pangea
Plate position adjusted
Meguma collides with Avalon as supercontinent Pangea forms
Crustal plates converge
Ancient ocean closes. Avalon Zone pressed against continental margin of North American plate.
Complex Precambrian history of the Avalon Zone.
Meguma Precambrian history unknown.
Fissures develop
Basalts extruded
MARITIME DISBURBANCE
Folding of Late Carboniferous, coal beds affected in Pictou ar
ACADIAN OROGENY
Folding produces Acadian Mountains. *GRANITES
TACONIC OROGENY
KEY
• Topics
Crustal Rocks
Topics: See Text

Fig. 7. Geological History of Nova Scotia.

In Nova Scotia the pieces of ancient continental crust that make up the Avalon Zone are found in the northern mainland (Cobequid Highlands and Pictou-Antigonish Highlands) and in Cape Breton (Cape Breton Highlands, Creignish Hills, Boisdale Hills, Sporting Mountain, Mabou Hills and the Fourchu lowlands), comprising regions 100, 200 and 300.

PART TWO: THE FORMATION OF PANGEA (about 400 million years ago)

Addition of the Meguma Zone

In the middle Devonian several lines of information indicate that European/Asian, African, North American and South American continental blocks moved together and began to form a 'supercontinent' called Pangea. During this process a thick pile of sediments, the Meguma Group, which had been accumulating in deep water off the coast of either North Africa or South America was squeezed against the Avalon Zone of northern Nova Scotia; in this way the Meguma Zone was added to the northern part of the Appalachian region. During this process the rocks on either side were folded and faulted. This event initiated the Acadian Orogeny.

At this time in the middle Devonian the Avalon Zone, already attached to North America, and the Meguma Zone were not in their present position with respect to one another. They were still several hundred kilometres apart. From middle Devonian through to the Permian, lateral slip took place along the Cobequid-Chedabucto fault which brought the two zones into their present positions (see fig. 10).

Metamorphism

During the disturbance of the Acadian Orogeny the folded and thickened pile of sediment was subjected to elevated pressure and temperatures. Their physical and chemical properties were altered on a regional scale, i.e. they were metamorphosed. All the rock strata in Nova Scotia which are older than Middle Devonian have undergone this kind of regional metamorphism, however, the intensity varies across the province. In general the pressure and temperature appear to have been greatest in the southwestern part of the province and in the area south of Canso. (Figure 9).

Granites

Also during the Acadian Orogeny, and as part of the same upheaval that produced the metamorphism, melting took place in the deep layers of the Meguma Zone. The molten rock or magma rose into the upper part of the earth's crust, cooled, solidified and became bodies of granite. The largest of these is the South Mountain Batholith (district 450).

Fault Movement

The Avalon and Meguma Zones in Nova Scotia actually slid into contact along a large fault which cuts across the central part of the province. It is known as the Cobequid-Chedabucto Fault but has also been called the Minas Geofracture. It is probably a transcurrent fault of the type mentioned in T2. The various phases of movement along this fault are illustrated in Figure 10.

PART THREE: NOVA SCOTIA WITHIN PANGEA 400 - 220 MILLION YEARS AGO.

Part of a 'Super-continent'

During the following 180 million years or so the juxtaposed Avalon and Meguma Zones lay towards the interior of Pangea and followed a common history. This period was marked by several events:

- the uplift and erosion of the fold mountains formed during the Acadian Orogeny
- a marine incursion over the area now called the Carboniferous Basin
- the withdrawal of the sea
- the exposure and erosion of the Carboniferous and older sediments under arid conditions at an equatorial latitude.

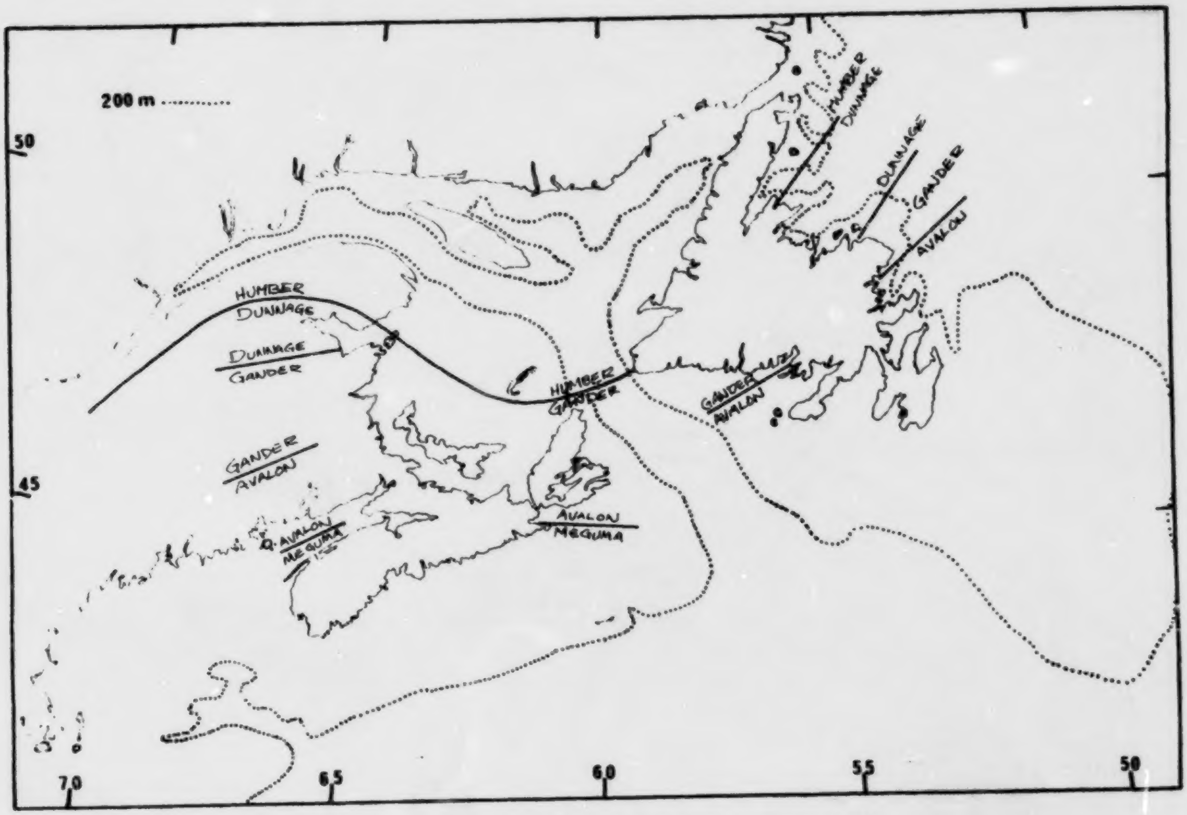

200 m
50
45
HUMBER
DUNNAGE
DUNNAGE
GANDER
GANDER
AVALON
AVALON
MEGUMA
HUMBER
GANDER
AVALON
MEGUMA
GANDER
AVALON
HUMBER
DUNNAGE
DUNNAGE
GANDER
GANDER
AVALON
70
65
60
55
50

Fig. 8. Geological Zones in Eastern North America.
Williams (1979)

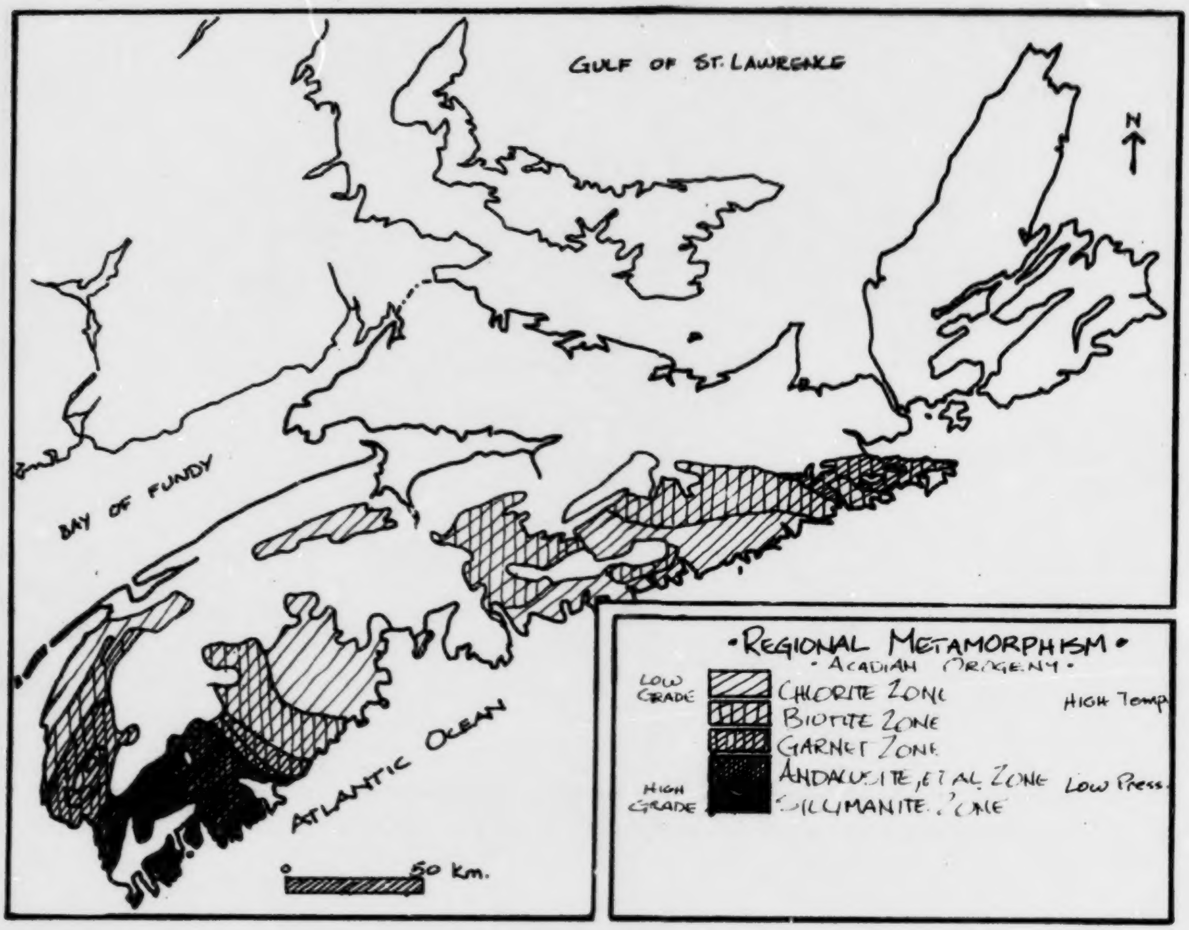

GULF OF ST. LAWRENCE
N
BAY OF FUNDY
ATLANTIC OCEAN
0
50 km.
•REGIONAL METAMORPHISM•
•ACADIAN OROGENY•
LOW GRADE
CHLORITE ZONE
BIOTITE ZONE
GARNET ZONE
ANDALUSITE, ET AL. ZONE
SILLIMANITE ZONE
HIGH GRADE
HIGH TEMP
LOW PRESS.

Fig. 9. Regional Metamorphism, Acadian Orogeny.
Keppie and Muecke (1979)

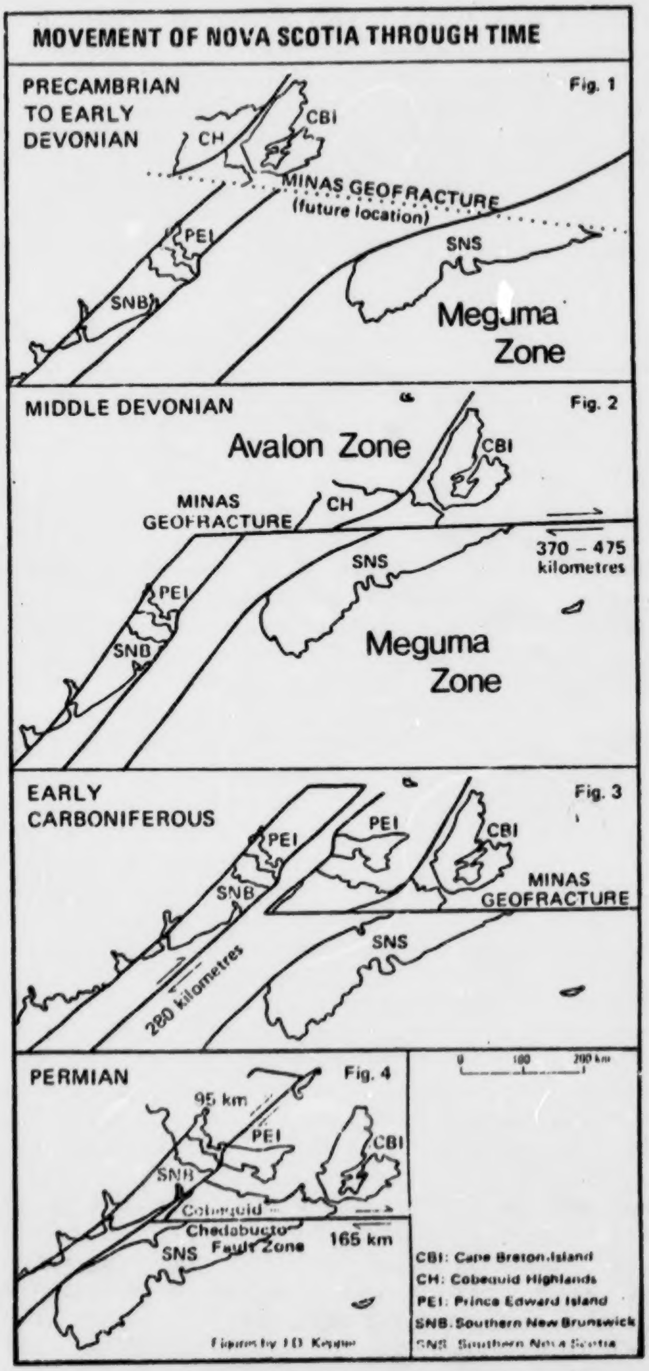

MOVEMENT OF NOVA SCOTIA THROUGH TIME
PRECAMBRIAN TO EARLY DEVONIAN
Fig. 1
CH
CBI
MINAS GEOFRACTURE (future location)
PEI
SNB
SNS
Meguma Zone
MIDDLE DEVONIAN
Fig. 2
Avalon Zone
CBI
MINAS GEOFRACTURE
CH
370 – 475 kilometres
PEI
SNB
SNS
Meguma Zone
EARLY CARBONIFEROUS
Fig. 3
PEI
PEI
CBI
SNB
MINAS GEOFRACTURE
SNS
280 kilometres
PERMIAN
Fig. 4
95 km
PEI
CBI
SNB
Cobequid
Chedabucto Fault Zone
165 km
SNS
0
100
200 km
CBI: Cape Breton Island
CH: Cobequid Highlands
PEI: Prince Edward Island
SNB: Southern New Brunswick
SNS: Southern Nova Scotia
Figures by J.D. Keppie

Fig. 10. Movement of Nova Scotia Through Time.
Bujak and Donohoe (1980)

During this period further adjustments took place in the alignment of the continental landmasses comprising Pangea. The effects of this movement were strongly felt elsewhere but in Nova Scotia their impact was slight; locally folding and faulting occurred and the event has been called the 'Maritime Disturbance'. This relatively uneventful period in terms of crustal movement ended about 220 million years ago, when lines of strain developed between the continental blocks of Pangea as crustal movement affected the area once more.

PART FOUR: THE ATLANTIC OCEAN OPENS 220 MILLION YEARS AGO TO THE PRESENT

Initial Rifting

In the Middle Triassic the continental masses began to move apart. The extension resulted in a linear fault system which runs along the Atlantic Seaboard of North America, passing through the Bay of Fundy, central Nova Scotia and out to Chedabucto Bay. Between these faults the strata moved vertically in blocks and some acted as channels for hot liquid basalt magmas. The magma either solidified within the faults as dykes, for example, the Great Dyke of Nova Scotia, or spilled out onto the surface as lava, for example, the North Mountain Flows (district 720).

Final Separation

The line along which the continents finally separated in the Early Jurassic was located further to the east of these faults along the present seaward margin of the continental shelf. The Avalon and Meguma rocks, together with their covering of Carboniferous and Triassic strata, were thus left on the western side of the proto-Atlantic.

The Atlantic Ocean continued to enlarge as a result of seafloor spreading and this process continues to the present day. The rifted margin became the site of active sediment accumulation and is the latest zone to be added to the eastern margin of North America.

Since the Triassic, Nova Scotia has gradually developed its present shape. It has remained a continental area continuously exposed to erosive forces and now has a morphology and coastline which reflects its long history of denudation.

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T4 Avalon and Meguma Zones, T5 Granite in Nova Scotia, T6 The Carboniferous Basin, T7 The Nova Scotian Desert, T8 The Triassic Basalts and Continental Rifting, T9 Offshore Geology and Resources.

REFERENCES

Bujak and Donohoe (1980)
Keppie (1979)
Keppie and Muecke (1979)
Williams (1979)

T4 The Avalon and Meguma Zones

A fault across Nova Scotia from Cobequid Bay to Chedabucto Bay neatly divides the province into two geological zones which are fundamentally different from one another. Prior to the Devonian period these zones developed in very different, widely separated areas, and later slid into contact along the Glooscap Fault.

AVALON ZONE

Distribution of Strata

Rocks of the Avalon Zone outcrop north of the Glooscap Fault. They range in age from Precambrian to Silurian, and are found in three areas: the Cobequid Highlands, the Pictou-Antigonish Highlands (districts 310 and 320), and in Cape Breton (regions 100 and 200, districts 310 and 330). They occur in fault-bounded blocks which stand out in the landscape as prominent ridges because they have been pushed up relative to their surroundings.

Earliest Record: A European Connection

Precambrian rocks are found in all three areas and, with the exception of volcanic deposits in southern Cape Breton, are severely altered. Granites were intruded late in the Precambrian and following this, in Cambrian times, a sea transgressed over the Cape Breton and Antigonish areas. These waters contained a prolific biotic community which included brachiopods, crinoids, trilobites and graptolites. Specimens were preserved and now represent the oldest true fossils in Nova Scotia. By comparing assemblages of these fossils with those found elsewhere, it has been concluded that the Avalon Zone was closely linked with both Europe and Africa during the Cambrian period.

Avaland Joins to North America

Between the Cambrian and Ordovician periods Avalon crust seems to have drifted away from Europe or Africa and moved towards North America. It is uncertain when it finally became part of eastern North America but the event probably occurred during the Ordovician - Silurian period. Much of the history of this interval has been interpreted using the fossils preserved in the Silurian and Devonian strata at Arisaig. These strata have yielded one of the most complete, well preserved and important fossil assemblages in eastern North America, and have been instrumental in unravelling the lower Palaeozoic history of the region.

The oldest sediments in the Arisaig section, are Silurian silts and muds, which were deposited on an old land surface made up of lava flows (Bear's Brook volcanics). As time passed the shallow sea which covered the area became increasingly populated by various forms of marine life which is now recorded in the fossil assemblages. Gradually the strata became sandier and the sea became shallower. Tidal effects were recorded in the strata for instance - winter storms, tidal flats and clam burrows. Eventually the area rose above the tidal range and riverbed deposits were laid down. Later movement along faults caused the old sea bed to be lowered once more and marine conditions were re-established.

As the Devonian period opened, the marine conditions changed; the sea became shallow and warmer. The whole landmass appears to have drifted towards the equator. The streams and rivers contained abundant life. Fish were preserved and are now found in the Knoydart area as fossils.

MEGUMA ZONE

Distribution of Strata

South of the Glooscap Fault, Meguma strata are widely exposed (regions 400 and 800). They underlie younger sediments and glacial deposits, and they extend out on to the continental shelf as an eroded basement upon which sediments have accumulated. The rocks of the Meguma Zone are much more uniform than those in the Avalon Zone, and have an entirely different origin.

An Offshore Basin

During the Silurian when the Arisaig strata were being deposited at the edge of North America, the Meguma sediments were being deposited in an offshore basin adjacent to a large continental landmass which had a relatively uniform geology. The landmass could have been either Africa or South America. The sediments were consolidated into two main rock types a) the greywackes of the Goldenville Formation and b) the shales of the Halifax Formation. These are generally regarded as being the older and younger sections respectively, but they can also be interpreted as nearshore and offshore deposits.

Depositional Environment

The environment of deposition has been described as deep cold water on the edge of a continental shelf. The sediments accumulated and were built out on the shelf as an embankment, then were carried rapidly down the slope in rolling gravity slides called turbidity currents. These are known to occur on continental slopes today and produce characteristic features such as slump structures, scour marks and sand volcanoes. Good examples of turbidity deposits can be seen preserved in the well exposed rocks at Taylors Head, Halifax County.

The active reworking of the deposits ensured that most records of life were not preserved. Those few graptolites that have been found, in conjunction with other evidence, indicate that the Meguma sediments were deposited between the Middle Cambrian and Early Ordovician periods. The sequence is very thick; at least 14 km of sediment were deposited. In volume this would have occupied a block with the surface area of Ontario and Quebec about 2 km thick.

During the Early Silurian there was some volcanic activity within the Meguma Zone, and this is now thought to be indicative of rifting within the crustal block as a new phase of crustal movement was initiated. These volcanic deposits, which include ashes and volcanic bombs, are called the White Rock Formation. They are now well exposed on Cape Fourchu, south of Yarmouth.

The youngest rocks in this sedimentary sequence are those of the Torbrook Formation which were deposited in the Early Devonian in shallower water. The climate was much warmer by this time (equivalent to that evident in contemporary deposits in the Avalon Zone), indicating that the whole section of crust had moved towards the equator and closer to North America.

Collision with North America and the Avalon Zone

During the Middle Devonian the continents of North America, Africa and South America 'collided'. The Meguma sediments were squashed against North America, metamorphosed, and deformed into folds aligned parallel to the suture line. These folds are now oriented northeast-southwest and are found in pre-Carboniferous sediments throughout both parts of the province. In the Meguma Zone the interfolded hard and soft bands of greywacke and slate create the subdued topography typical of the southern part of the province.

The Acadian Orogeny also initiated melting of sediments in the lower parts of the crust, from which a granite magma separated and rose. Eventually it cooled and crystallized in the upper part of the Meguma sedimentary pile at a depth of about 1.25 miles (2 km).

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean.

REFERENCES

Bujak and Donohoe (1980)
Clarke and Muecke (1980)
Donohoe and Wallace (1980)
Grantham (1979)
Roland (1982)
Schenk *et al* (1980)

T5 Granite in Nova Scotia

Granite is a hard impermeable crystalline rock which is resistant to erosion. In Nova Scotia it tends to form knolls and upland areas characterized by a hummocky boulder strewn surface, thin acid soils and large areas of exposed bedrock. Water can only penetrate the body of granite along the joint lines which may be several metres apart. Most precipitation is therefore held on the irregular surface in numerous interconnected bogs, shallow lakes and streams.

Granite is found throughout mainland Nova Scotia and Cape Breton in plutons of various sizes, and represents about 20-25 percent of the bedrock across the province. The largest pluton is the South Mountain Batholith. It is the largest found in the Appalachian region of eastern North America, and is the dominant feature in the landscape of southwestern Nova Scotia. It extends in an arc from Yarmouth to Halifax and outcrops over an area of 4,000 square miles (10,000 km^2) (Figure 11).

AGE AND GENESIS

The family of rocks which are included under the general name of granite are characterized by having a composition dominated by two minerals; quartz and feldspar. Many theories exist to explain the origin of granite but all conclude that in most cases it forms from a hot, molten liquid called magma. The dispute centres on how the liquid forms - where and in what form.

Age studies show that in Nova Scotia the granites appear to have formed during at least two periods of intense crustal disturbance when sediments may have been thrust deep into the Earth's crust and melted. These two major occasions were during the Precambrian/Cambrian period and the Devonian/Carboniferous period. One theory states that these may have been times of relatively high activity along crustal plate boundaries.

The older group of granite plutons is composed of relatively small bodies which are found exclusively north of the Cobequid-Chedabucto fault in northern mainland Nova Scotia and Cape Breton. Little more is known of their genesis. The younger group are found throughout the province, but predominantly south of the Cobequid-Chedabucto fault, within the metamorphosed sediments of the Meguma Zone. These were generated during the Acadian Orogeny, when the thick Meguma

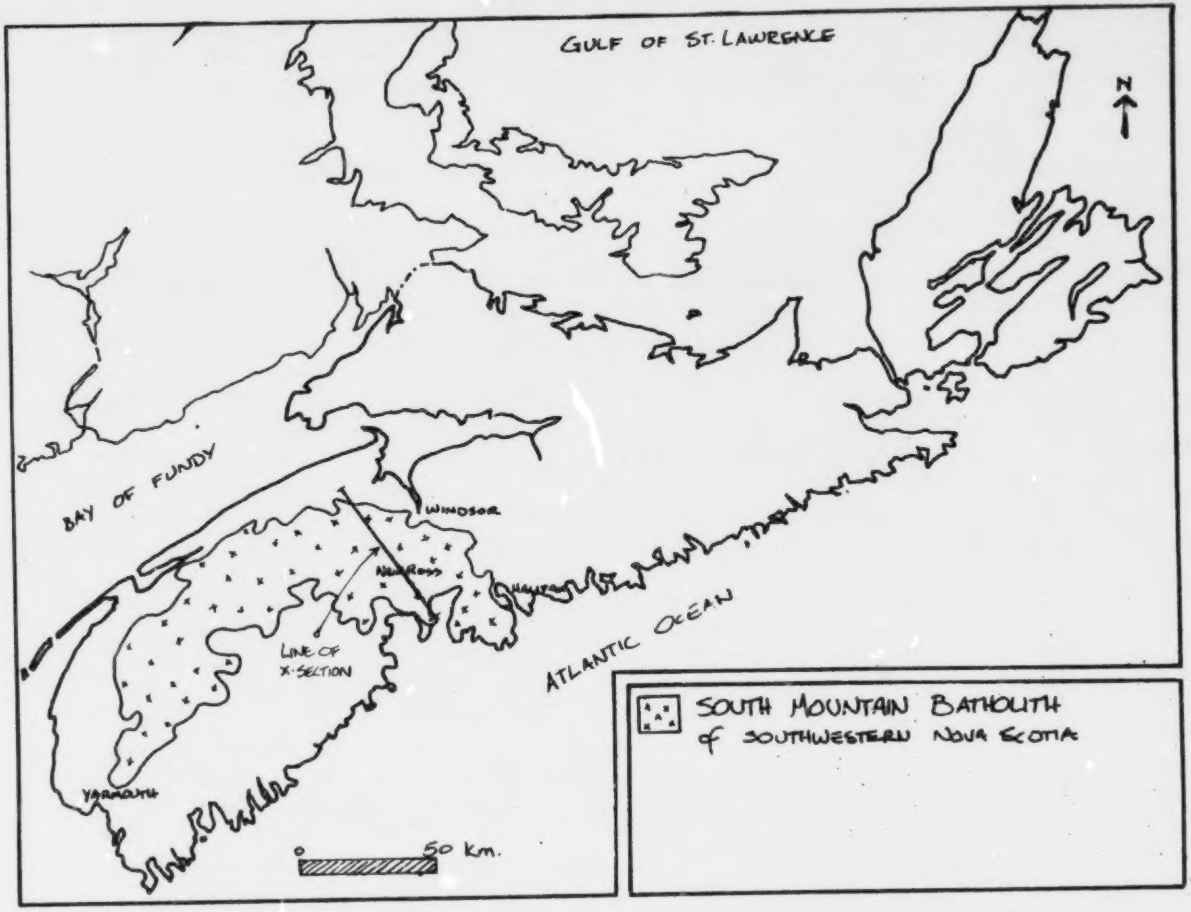

GULF OF ST. LAWRENCE
N
BAY OF FUNDY
WINDSOR
NEW ROSS
LINE OF X-SECTION
ATLANTIC OCEAN
YARMOUTH
0
50 km.
SOUTH MOUNTAIN BATHOLITH of SOUTHWESTERN NOVA SCOTIA

Fig. 11. South Mountain Batholith. Charest (1976)

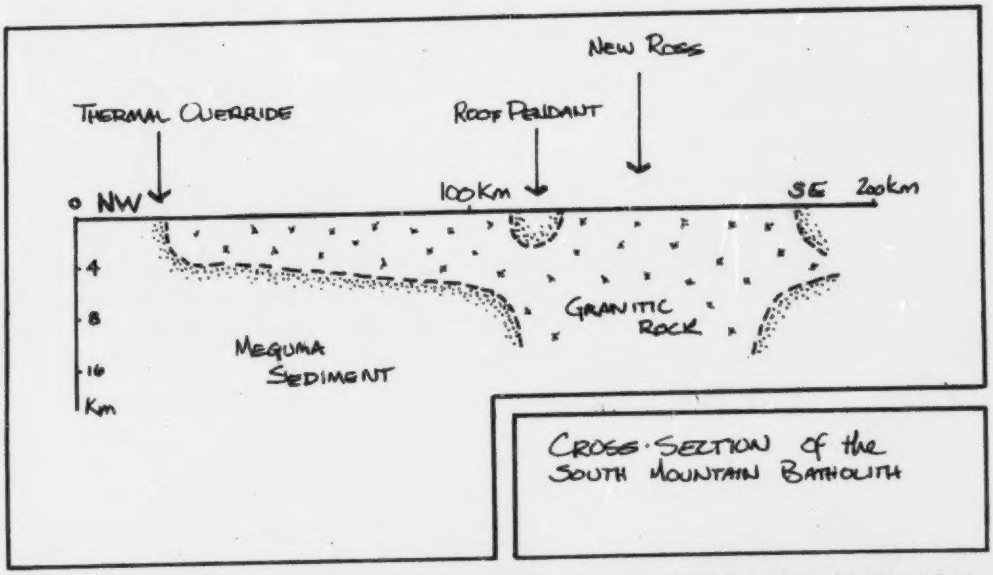

New Ross
THERMAL OVERRIDE
ROOF PENDANT
0 NW
100 Km
SE
200 km
4
8
16
Km
GRANITIC ROCK
MEGUMA SEDIMENT
CROSS-SECTION of the SOUTH MOUNTAIN BATHOLITH

Fig. 12. Cross Section Through South Mountain Batholith based on interpretation of gravity data.
Charest (1976)

sedimentary pile would have been squeezed against the Avalon Zone. The South Mountain Batholith (districts 440 and 450), a very large body of granite which underlies about half of western Nova Scotia, falls within this younger group. It has been studied extensively during the past ten years or so and is the best known of the granite bodies in the province. The description which follows is basically that of the South Mountain Batholith although most other Devonian/Carboniferous plutons are likely to share similar characteristics.

MODE OF EMPLACEMENT

Ascent of the Molten Rock

A hot magma which forms at a depth of 10-25 miles (20-40 km) in the Earth's crust may rise either by forcing a path along lines of weakness or by breaking off and incorporating overlying rocks. There are no signs of strain within the sedimentary rocks surrounding the South Mountain Batholith which might indicate forced passage, but several signs indicative of ascent by incorporation of blocks from the overlying strata (called country rock).

The contact with the surrounding Meguma country rock is generally steep and in several places blocks of sediment, some with obvious sedimentary banding, are incorporated into the granite mass. These blocks, or xenoliths, are gradually assimilated by the hot magma and can be found in various degrees of alteration in several localities near the margins of the granite, for example at Portuguese Cove. The process of ascent by invasion and incorporation of country rock is called 'stoping'. In places fingers of sediment project into the granite from its roof as pendants. These can be seen in various locations along Highway 101 and in the New Ross area (Figure 12).

COOLING OF THE MAGMA

Convection

As the magma cools, crystals form which move in response to thermal convection currents. Some remain in suspension whereas others settle out into dense patches. The flow patterns can often be seen in the distribution of feldspar which forms large, blocky, greyish or flesh coloured crystals often aligned in flow patterns.

Baking of the Surrounding Sediments

The heat which is given off by the liquid as it cools, bakes the surrounding sedimentary rocks for several miles. This is the thermal aureole of the granite. The physical change that takes place in the sediments is called thermal metamorphism. In general this takes the form of hardening and recrystallization together with the growth of some new minerals. The most characteristic of these is the round black mineral called cordierite which gives the rock a spotted appearance - thus the derivation of spotted slates.

Mineral Deposits in Veins

As the crystal mush cools and solidifies it contracts, creating fractures along which the last remaining fluid can flow. This fluid is superheated water in which silica and certain metals are dissolved. As the fluid cools fractures within the body of granite and in the surrounding country rock become filled with veins of quartz (silica as a mineral) and metallic minerals. Some of these veins may contain metallic deposits rich enough for them to be considered as ore.

In southern mainland Nova Scotia the granites are associated with deposits of uranium, tin and tungsten. Current exploration has located several promising deposits, some of which may eventually be commercially exploited. The largest concentrations, however, were probably located underneath the sedimentary roof of the batholith and were eroded away when the granite was exposed during the Carboniferous period.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T4 Avalon and Meguma Zones, T10 Land-based Economic Deposits

REFERENCES

Charest (1976)
Clarke *et al* (1980)
Clarke and Muecke (1980)
Cooke (1972)

T6 The Carboniferous Basin: An Inland Sea

Most of the central and northern parts of mainland Nova Scotia and much of Cape Breton are covered with sediments deposited during the Carboniferous period (region 500). Deposition occurred in a progressively subsiding and enlarging basin, in which the Pictou-Antigonish and Cape Breton fault blocks stood like islands. The Cobequid hills were not a highland area at this time. They emerged as a landscape feature later in the Carboniferous.

Several thousand metres of sediment were deposited in the Carboniferous Basin. The majority were represented by the older sands and gravels of the Horton Group which were covered by a few hundred metres of salts precipitated from evaporating sea water (the Windsor Group). These strata, now gently folded and dissected, have produced a varied landscape. The Windsor deposits form a lowland topography which is interrupted by hills and bluffs of resistant Horton sandstones. During the late Carboniferous period swamps and bogs developed along the shorelines of lakes and on quiet flood plains. These have become Nova Scotia's coal deposits.

THE HORTON SANDS

Paleogeography At the beginning of the Carboniferous period, following the eventful Devonian period, Nova Scotia lay landlocked towards the interior of the supercontinent Pangea. In the south was a rugged area made up of the Acadian Mountains (the eroded remnants of these now form the Southern Uplands), and an earthquake zone along the Cobequid-Chedabucto fault. The northern part of the province had moderate to low relief; it was a lowland relative to the rugged topography in the south.

The Acadian Mountains, the granite, and the rubbly rocks from the fault zone were rapidly eroded. Fast-flowing streams and rivers carried coarse sands and gravels down into the lowlands where they spread out and accumulated in a shallow restricted basin. As the highland was eroded the South Mountain granite became exposed and contributed to the sandy sediments accumulating in the basin. As the basin became increasingly loaded with sediments it subsided and widened. The younger deposits overlapped the older ones and then thinned out against the Southern Uplands to the south and the New Brunswick platform to the north. Plant and animal remains were quickly destroyed in the high energy environment and few fossils have been preserved.

Distribution

Horton strata are exposed in a wide band which stretches from Kings County to Northern Cape Breton. Around the edges of the basin, where the coarsest material was dropped, exposed Horton strata forms resistant shoulders; examples are found on the west side of the Creignish Hills and the Cape Breton Highlands (districts 580 and 590). Within the basin the Horton sediments are finer; sandstones and siltstones are exposed in many places. Good examples can be seen along the Avon River at Horton Bluff north of Hantsport, and in Victoria Park, Truro.

Eventually the relief of the land area around the basin was reduced; the streams became slower and progressively finer material was deposited. Eventually seawater flooded into the basin from the east forming an inland sea which had restricted connections to the remnant ocean left between the continents. At its most extensive this body of salt water was called the Windsor Sea.

THE WINDSOR SEA

Formation of Deposits

The earliest marine deposits were restricted to a narrow trough which extended from the Minas Basin, Nova Scotia to St. George's Bay in Newfoundland (especially districts 510 and 560 but throughout region 500). It gradually enlarged to cover an area measuring approximately 375 by 90 miles (600 km by 150 km), and extended across much of central and eastern Nova Scotia, the southern half of New Brunswick, Prince Edward Island, and parts of southwestern Newfoundland (Figure 13).

From the beginning of the Carboniferous period the climate had been undergoing a warming trend, Pangea was moving northward, and Nova Scotia was approaching the equator. Interchange of water with the distant ocean was

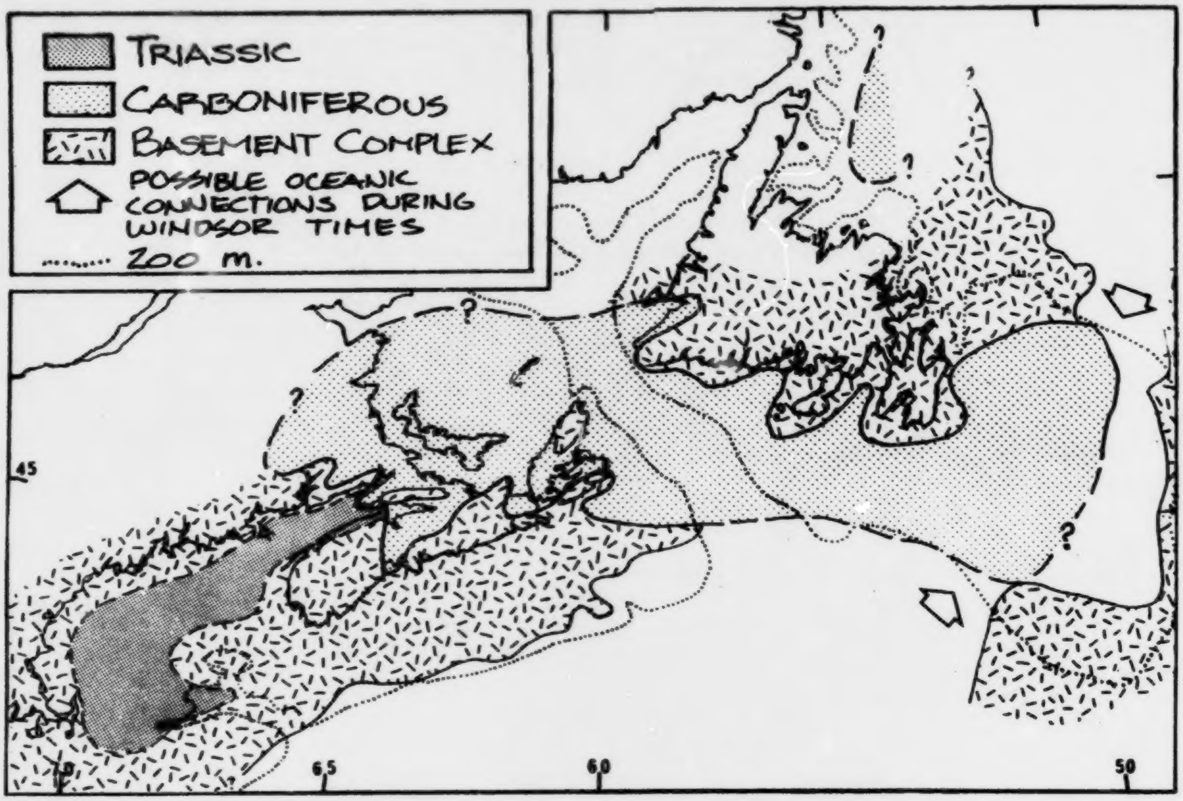

TRIASSIC
CARBONIFEROUS
BASEMENT COMPLEX
POSSIBLE OCEANIC CONNECTIONS DURING WINDSOR TIMES
200 m.
?
45
65
60
50

Fig. 13. Palaeo-geographic Extent of Windsor Sea.
Jansa and Wade (1975)

restricted and marine incursions were probably sporadic. In between pulses the salts within this evaporating body of water became increasingly concentrated and began to precipitate. These deposits are jointly referred to as the Windsor Group.

The first fine precipitate was of calcium carbonate, which formed a richly fossiliferous thin band of fossiliferous limestone. The fossils show strong affinities with European fauna of the same age, indicating that there was a marine connection between these two parts of Pangea.

As evaporation continued and the concentration of other salts increased, gypsum and anhydrite - two forms of calcium sulphate - were precipitated in large quantities. These deposits are interbedded with red and green shales which seem to represent intermittent periods of flooding, when silt was carried into the basin. Eventually, in the final stages of evaporation, rock salt (sodium chloride) and some potassium deposits were formed. This cycle of sedimentation from limestone to salt was subsequently repeated several times as the Windsor Sea was periodically recharged. Each renewed marine invasion is recorded by a thin band of fossiliferous limestone.

A complete sequence of these limestone bands and evaporite deposits can be seen in a one-mile section northeast of the wharf at Newport Landing (near Avondale). Brachiopods, bryozoans, cephalopods, gastropods, pelecypods and corals can all be found within the limestone bands.

Unlike the coarse gritty strata of the Horton series, the Windsor deposits are fine grained, easily abraded, and soluble in rainwater to varying degrees. They typically are lowlying with little relief. The features of this type of terrain can be brought together under the name of karst topography. It is characterized by solution channels on the surface; sinkholes where streams disappear into underground channels; caves and occasionally collapsed caverns. The surface and groundwater chemical characteristics are also distinctive, and generally support more productivity in aquatic habitats than the adjacent areas of sandstone, slate, greywacke and granite.

Economic Importance

The Windsor deposits are important economically since gypsum, anhydrite, limestone and salt are all quarried or mined actively; the bulk of this extracted material is exported. The most productive gypsum and anhydrite quarries are found in Hants County and Inverness County; salt is extracted exclusively from deposits in Cumberland County. Some limestone deposits are exploited for industrial purposes but these strata are economically important for another reason - they serve as the host for the deposition of certain base metals. The Gays River lead/zinc ore body, for instance, is found within a limestone sequence.

Climate Change

By the end of the Windsor period of deposition the landscape had been reduced to a low-lying terrain with the slowly eroded sediments deposited as fine silt in quiet water. The climate was still warm, but changing from arid to humid. During a period of gentle uplift at this time the Cobequid fault block began to rise and the coastline of the sea withdrew to the east. Some coarse gravelly deposits accumulated along the eastern margin of the rising Cobequids (district 580), as they in turn became a new target for erosion. In this tropical climate and quiet environment, a dense cover of vegetation spread across estuaries, deltas and floodplains. This was the beginning of the Coal age.

THE COAL AGE

Paleogeography

In the Late Carboniferous Nova Scotia had a subdued topography of low hills separated by broad river valleys and fresh water lakes. The marine shoreline lay to the east over northern Cape Breton. Vegetation flourished in the warm climate, particularly large trees, some 100 feet (30 m) high, and swamp plants. Some of the swamp plants had large tops and laterally spreading roots which were ideally suited to the topography with its wide, flat, poorly drained surfaces. These plants grew densely in bogs and swamps along the floodplains, estuaries and shorelines of lakes and possibly in coastal areas. As the plants died and decayed they became buried and compressed by new organic material growing above. Some of these environments were stable for millions of years, experiencing only gentle subsidence or rhythmic oscillations in elevation. In these locations tremendous thicknesses of organic material accumulated, were compressed, and eventually turned into coal.

In the Maritimes coal may have been deposited in two types of basins, a) along lakes and river floodplains which were regularly, probably annually, flooded and, b) in coastal lowlands subject to periodic, sustained influxes of seawater and marine sediments. All the coalfields in mainland Nova Scotia are of the first type. The coal seams tend to be thick but short, and grade vertically and laterally into coaly-shale and shaly coal. The coalfields of Cape Breton (districts 520, 530 and 550) may be of the second type (except for Mabou). They tend to have numerous thick, continuous seams, plus many thin ones, separated by thick bands of rock. In general these seams are easier to work and the deposits are more productive.

Occurrence

The coal age began in Nova Scotia with the deposition of sandstones, black shales and thin coal seams in the Riversdale Group. Exposures of these strata are limited and few contain economically important coal seams; the most extensive are those in the Port Hood area of Cape Breton. More productive coal measures are found in the succeeding Cumberland and Pictou Groups (districts 520 and 580). The strata are predominantly sandstone and contain few fossils, however, a striking exception to this is the 5,500 feet (1,700 m) of Cumberland sandstones which is exposed along the Chignecto Bay shoreline near Joggins and contains fossil trees. In the Joggins section there are also 65 coal seams, 39 of which are also found at Springhill. Other seams have also been worked at Debert. The Pictou coalfield formed in the sandstones of the Pictou Group occupies an area of 2 by 9 miles (3 by 15 km). It has numerous short, thick coal seams and some deposits of oil shales (some oil has been collected dripping from the roof of the Thorburn colliery).

At Mabou and Inverness in Cape Breton, the coalfields barely touch the land and lie mainly under the waters of the Gulf of St. Lawrence. Similarly only 3 percent of the huge Sydney coalfield is found onshore. The seams run for 20 miles (30 km) along the coast but dip northeastwards under the Cabot Strait and extend all the way to Newfoundland. These deposits are part of the Late Carboniferous Morien Group.

THE 'MARITIME DISTURBANCE'

At the end of the Carboniferous there was a small-scale crustal disturbance in Nova Scotia which produced folds and faults in a narrow band between the Cobequids and the Southern Uplands. This was the shadow of a much larger disturbance felt in Europe and the rest of the Appalachians, and marked the final readjustment in the grouping of continents in Pangea. The coalfields within this band, particularly the Pictou field, were distorted and the seams disrupted, thereby reducing their economic value. The coalfields of Cape Breton however were almost undisturbed.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T10 Land-based Economic Deposits

REFERENCES

Bujak and Donohoe (1980)
Geldsetzer *et al* (1980)
Hacquebard (1980)
Hamish and Lees (undated)
N.S. Dept. of Mines and Energy (1976)
Roland (1980)

T7 The Nova Scotian Desert

By the close of the Carboniferous period, 280 million years ago, the shoreline of the inland sea had withdrawn to the east, and almost the entire surface area of Nova Scotia was above sea level. Only part of Cape Breton remained under water. This marked the beginning of the continental phase of the province's geological history. Since that time it has never been appreciably covered by fresh or salt water, but has been exposed to continuing subaerial erosion.

PERMIAN 280-230 MILLION YEARS AGO

As the Permian period opened Nova Scotia was still part of Pangea. It was close to the equator and exposed to a hot dry climate. The rocks on the land surface became oxidised, were eroded as red sands and muds, and deposited in the inland sea covering the area over the Northumberland Strait, Prince Edward Island and the Gulf of St. Lawrence. Sediments derived from older strata in Nova Scotia and New Brunswick were redeposited within this basin, and today form the foundation for the rolling landscape of Prince Edward Island.

At that time the landscape of Nova Scotia was probably gently undulating, rather uniform, and part of a continental expanse which extended to the west over New Brunswick and beyond, and to the east into the other continental areas of Pangea. Any Permian deposits which may have formed on land have been completely eroded away, and are not even found offshore on the Scotian Shelf. The shelf therefore may also have been dry land.

TRIASSIC to JURASSIC (230-140 million years ago)

During the Triassic, tensional features developed along the eastern seaboard of the North American continent as the crustal blocks of Pangea began to move in divergent directions. These features were subparallel fissures and faults. In some cases the block of crustal material between parallel faults dropped down forming steep sided, flat-bottomed valley-type structures called 'graben'. One of these graben features developed in the Bay of Fundy area, and can be traced through mainland Nova Scotia to Chedabucto Bay (district 570) and out onto the Scotian Shelf (Stevens 1980).

In the Fundy area rivers from the south deposited coarse red beds of sands and pebbles which are now the Wolfville Formation (region 600). These were covered initially by silts and muds (Blomidon Formation) deposited in temporary lakes, and finally by several lava flows (North Mountain Formation region 700). Above the basalt are the muds, sands and limestones of the Scots Bay Formation. The basalts straddle the Triassic-Jurassic time boundary and the Scots Bay Formation is thought to be entirely within the Early Jurassic. This full sequence is called the Fundy Group and is the thickest deposit of that age in eastern Canada. Fossils are rare in these deposits but occasional plant remains, dinosaur tracks and bones have been found. The best exposures of these can be seen in the cliffs near Kingsport, and on the west side of Five Islands provincial park. Also in this area at Red Head, near the park, are several good exposures of sand dune deposits which provide excellent evidence of desert conditions.

The Fundy Group was protected from erosion because it accumulated within the graben. The whole sequence was gently folded at a later time, and now has the shape of a tilted saucer which dips westwards towards the Bay of Fundy. It is well exposed along the south shore of the Bay in the North Mountain-Annapolis Valley region. The late Triassic paleogeography is shown in Figure 14.

The final deposit to form in the Late Triassic to Early Jurassic was the Scots Bay Formation. It is composed of fine sediments, sandstones and siltstones, and although it is thick and extensive on the floor of the Bay of Fundy, it is now preserved in only a few localities - one of them being Scots Bay. Fossil fish have also been found in these sediments, as well as dinosaur footprints.

There are no Late Jurassic deposits to be found on land in Nova Scotia. Evidence of climatic changes and geological events during that period must therefore be sought from the sedimentary record on the Scotian Shelf. The presence of red beds and salt in the offshore sequence indicates that the arid equatorial climate persisted into the Late Jurassic.

The most recent, pre-glacial deposits in Nova Scotia are Cretaceous sands, clays and lignite in the Musquodoboit Valley near Middle Musquodoboit.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T6 The Carboniferous Basin: An Inland Sea, T9 Offshore Geology and Resources.

REFERENCES

Dietz and Holden (1970)
Jansa and Wade (1974)
Roland (1982)
Stevens (1980)

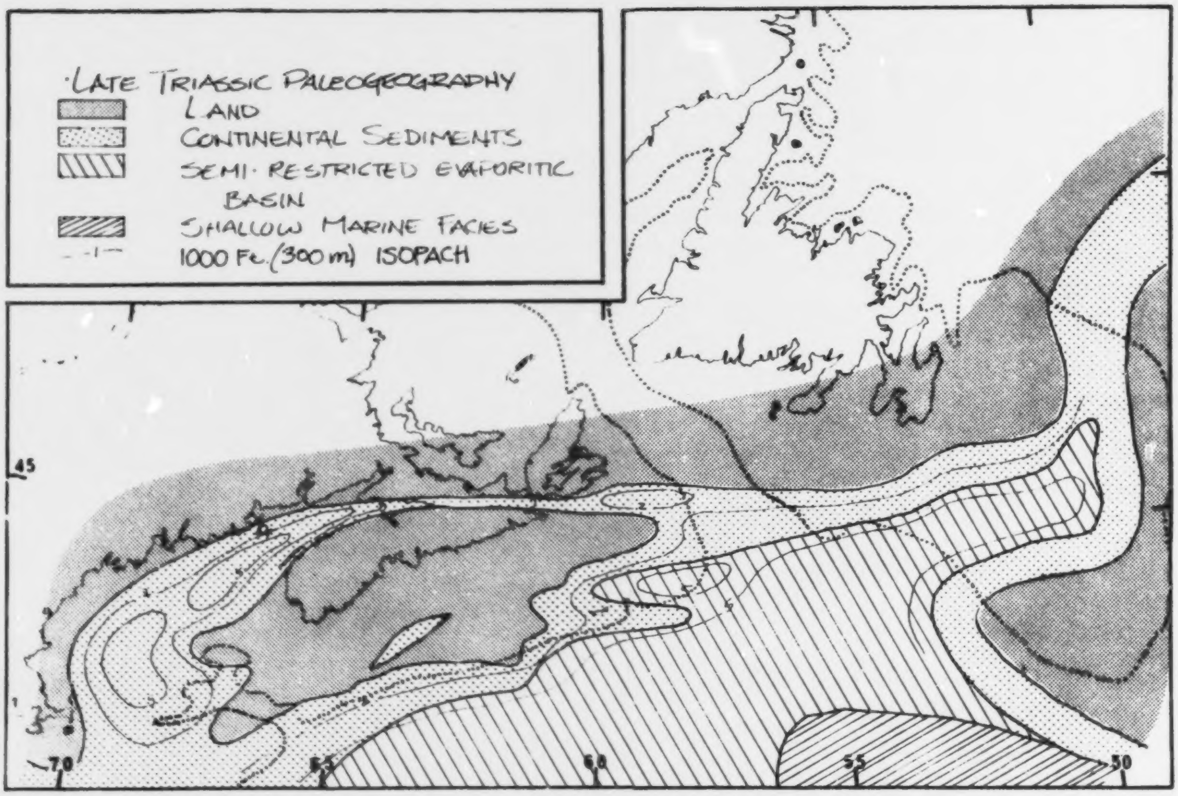

LATE TRIASSIC PALEOGEOGRAPHY
LAND
CONTINENTAL SEDIMENTS
SEMI-RESTRICTED EVAPORITIC BASIN
SHALLOW MARINE FACIES
1000 Ft. (300 m) ISOPACH
45
70
65
60
55
50

Fig. 14. Late Triassic Paleogeography.
Jansa and Wade (1975)

T8 The Triassic Basalts and Continental Rifting

In the long geological time period up until the end of the Carboniferous almost all of Nova Scotia's geological building blocks were assembled, ie. the old crystalline rocks of the Avalon Zone, the folded slates and greywackes of the Meguma Zone, the Devonian granites, the Carboniferous limestones, salts, sandstones and coal. These were then eroded under a hot dry climate during the Permian and Early Triassic.

During the 150 million years prior to the Triassic period Nova Scotia lay within a continent. Pangea had started to form in the Devonian period, and by Late Carboniferous times was complete. In Nova Scotia the Permian period was uneventful. During the Triassic a new phase of continental movement began. It eventually resulted in the dispersal of the continents comprising Pangea and the formation of the Atlantic Ocean. But in many respects its earliest manifestations are the most significant for Nova Scotia for at that time the last geological building block was added, the Triassic basalts and sediments. Also various important coastal features began to form: the Bay of Fundy; Chignecto Bay; the Minas Basin and Chedabucto Bay.

CRUSTAL MOVEMENT BEGINS

Faults and Graben

As the conveyor belt-like movement was initiated in the Earth's mantle, strain developed in the continental crust. This was manifest in the development of tensional features well to the west of the actual splitting line along what is now the eastern seaboard of North America. In some cases the block of crust between two parallel faults dropped down making a steep sided valley-like depression called a graben. In Nova Scotia a series of graben or half-graben (downfaulted on only one side) developed which ran along the Bay of Fundy into the Minas Basin, across the province south of the Antigonish Highlands (St. Mary's Graben), through Chedabucto Bay and out onto the eastern continental shelf (the Orpheus Graben). Another branch may be represented by the Cabot fault system (Figure 15). These graben gradually filled with sediment. The boundary faults remained as lines of weakness however, and were later exploited during erosion. They are now features of inland and coastal morphology.

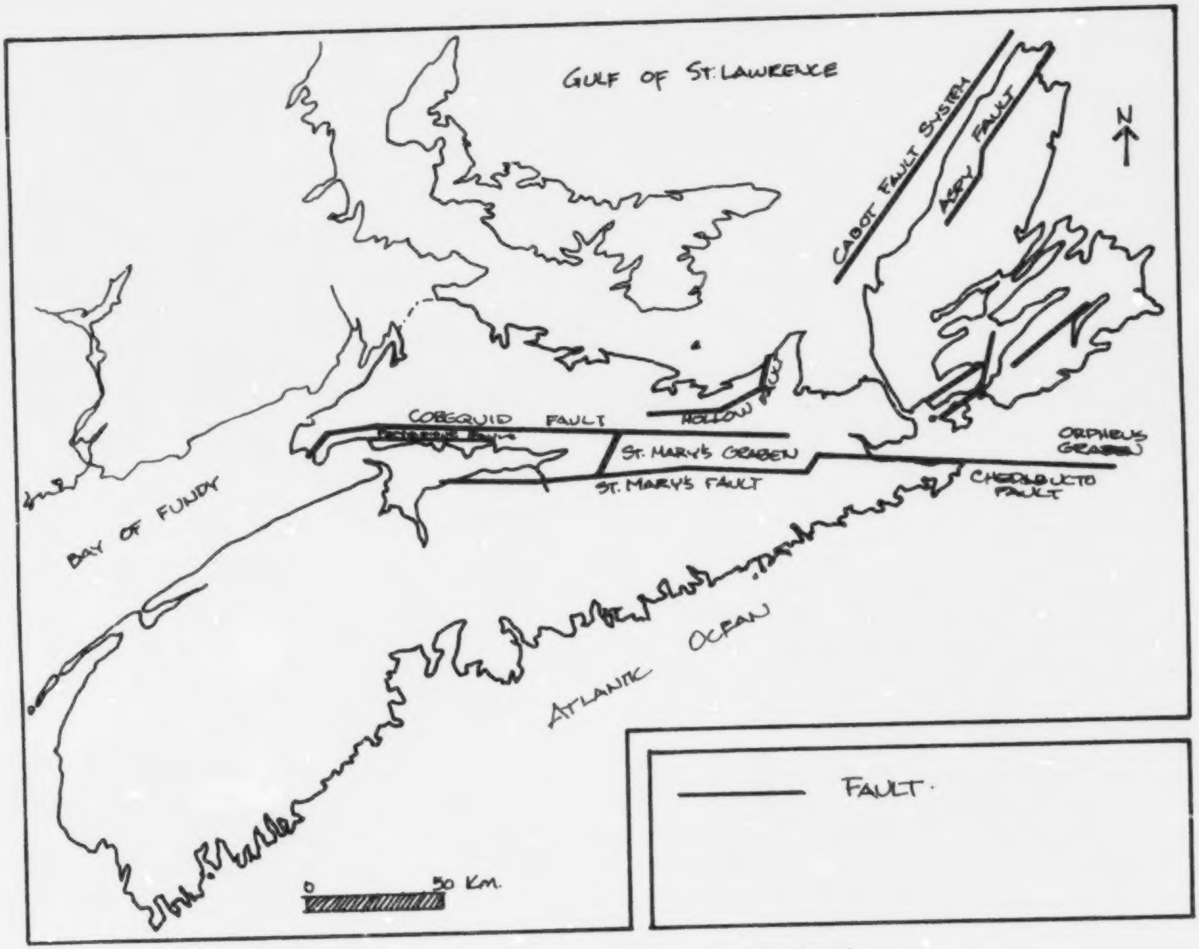

GULF OF ST. LAWRENCE
N
CABOT FAULT SYSTEM
ASPY FAULT
COBEQUID FAULT
HOLLOW
ST. MARY'S GRABEN
ST. MARY'S FAULT
ORPHEUS GRABEN
CHEDABUCTO FAULT
BAY OF FUNDY
ATLANTIC OCEAN
0
50 Km.
FAULT

Fig. 15. Major Fault Systems. Stevens (1980)

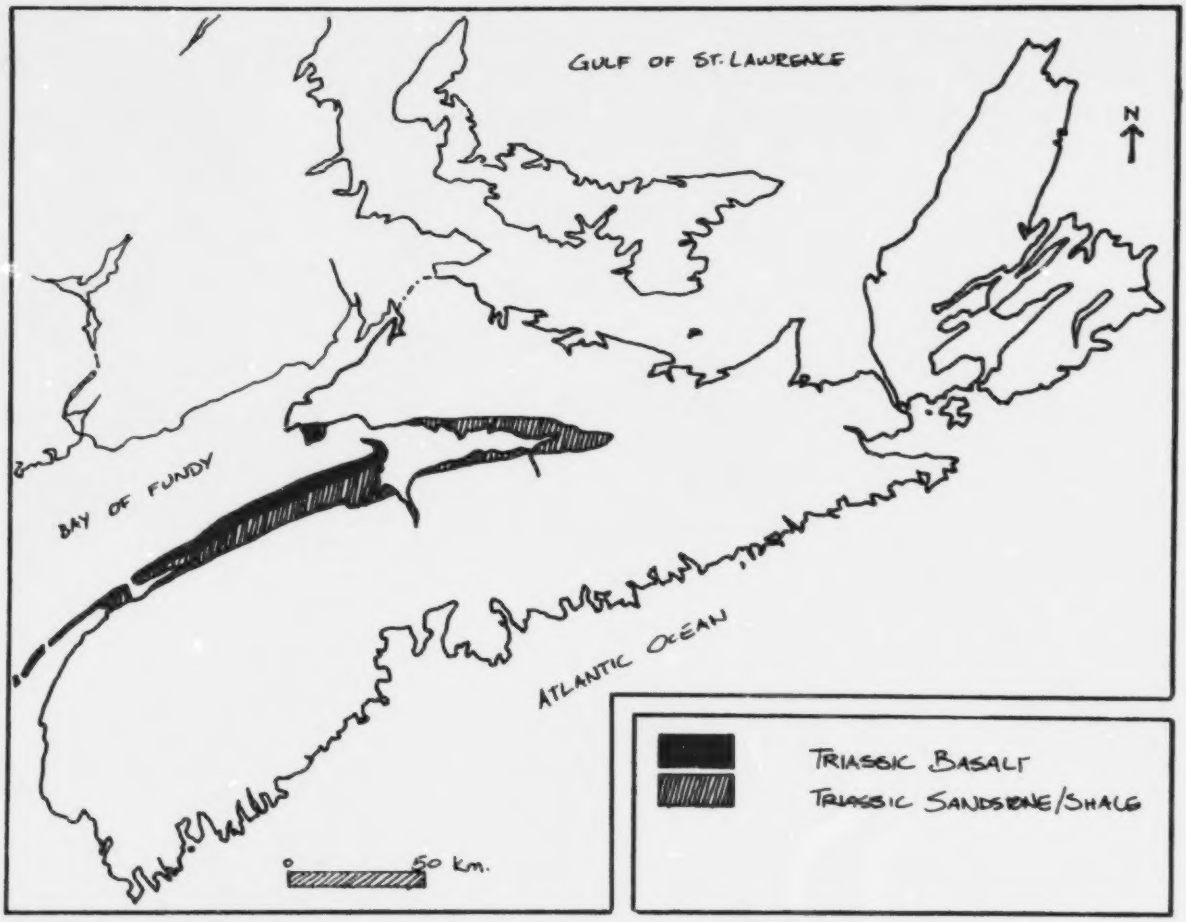

GULF OF ST. LAWRENCE
N
BAY OF FUNDY
ATLANTIC OCEAN
0
50 km.
TRIASSIC BASALT
TRIASSIC SANDSTONE/SHALE

Fig. 16. Triassic Rocks. Colwell (1980)

BASALT

During this period of sustained tension basalt welled up some fractures and either solidified as dykes and sills within the rock strata or was extruded at the surface as lavas (Figure 16). Several closely spaced eruptive centres may have existed in the Bay of Fundy region, pouring lava over an area of about 4,000 square miles (10,000 km^2). These basalts are now exposed as the continuous ridge of North Mountain (districts 810 and 720, extending from Brier Island in the west to Cape Split in the east), in fault blocks along the north shore of the Minas Basin (district 710), on Isle Haute, and on Grand Manan Island (New Brunswick).

The Flows

At least 17 flows have been identified in the Bay of Fundy area. They vary in thickness from 3-200 feet (1-60 m); most only cover a small area. All 17 are exposed northeast of Digby Gut, but to the southwest along Digby Neck only two very thick ones are found. These two are separated by a layer of more easily eroded rock which forms a valley down the centre of the Neck and out onto the islands.

When thick lava flows cool and contract, six sided vertical joints form which divide the flow into columns (columnar jointing). If these columns are undercut at their base by the sea they tend to fall like chimneys. Cliffs formed by these flows therefore tend to be high, vertical, and have a wave cut platform at the base. Basalt coastal features are well displayed at many points along the southern Fundy shore from Cape Split to Brier Island.

Minerals

As the lavas cooled after extrusion, escaping gases were trapped in the rock and formed cavities in which various minerals were precipitated; filled cavities are called amygdales. The minerals include agate, amethyst, jasper and the zeolite family of minerals. Agate and jasper can be found as pebbles along the beach at Scots Bay and zeolites occur at various localities along the Fundy shore. For an extensive list of mineral sites see Sabina (1972).

Sills and Dykes

A sill is a layer of basalt which was injected in between strata and therefore lies parallel to them. In Colchester County the basalt near Five Island Provincial Park does not have the usual amygdales. It may therefore not have been extruded as lava, but injected between the Wolfville sandstone and the Blomidon shales as sills. In southern Nova Scotia basalt is found in small dykes in the Yarmouth area, and in the Great Dyke of Nova Scotia - a feature that runs from Pubnico 100 miles (150 km) eastwards to just off Sambro near Halifax Harbour. Dykes cross-cut the sedimentary banding and structures occupying the tensional fissures produced during the rifting process.

MORPHOLOGY OF THE TRIASSIC AREA

Late in the Triassic more faulting took place. The principal faults developed parallel to the Colchester/Cumberland shore south of the Cobequids, but some also formed in a NE-SW direction in the same area. The blocks of strata between these faults were shifted and tilted; they now form an irregular hilly topography along the north shore of the Minas Basin from about Great Village to Five Islands. To the east, around Cobequid Bay, the Triassic deposits form lowlands.

On the south side of the Bay of Fundy the sandstones, shales and basalts gently sag down to form a spoon shape which dips down and opens out towards the west. The apex of this gentle fold can be seen in the hook of Cape Split. The south side of North Mountain is truncated by a sharp scarp slope, possibly a fault, behind which the soft Wolfville and Blomidon Formations have been eroded to form the Annapolis-Cornwallis Valley.

CONTINENTAL SPLITTING

When the continents finally did move apart in the Early Jurassic the split did not occur along the lines of the tensional features but further to the east along the edge of the continental shelf. Thus the Meguma rocks which had originally been attached to another continent were left behind on the west side of the Atlantic Ocean, joined to eastern North America.

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia

REFERENCES

Bujak and Donohoe (1980)
Colwell (1980)
Roland (1982)
Sabina (1972)
Stevens (1980)

T9 Offshore Geology and Resources

Since the Cretaceous period 65 million years ago Nova Scotia has been continuously exposed to erosive forces. Its history from this point is essentially one of denundation rather than deposition and consequently very little evidence of geological events on land has been preserved. This gap in the historical sequence of events is filled by the geological record in the offshore area. Here the basal folded and metamorphosed Meguma rocks are covered by the coarse sands of the Early Carboniferous Horton Group. The irregular, eroded upper surface of this 'basement' is overlain by Jurassic and younger sediments which were deposited when seawater inundated the shelf at the end of the long period of exposure under continental desert conditions.

Subdivision of the 'Offshore'

The offshore is here taken to be that area of the continental shelf that surrounds Nova Scotia and extends out to the furthest 200 m bathymetric line. It can be divided into three parts:

a) A marine extension of the land in which there is only a thin covering of sediments over the basement rocks. The sediment blanket is predominantly of glacial origin. Three depressions on this zone containing sedimentary sequences are the Fundy Basin, the Sydney Basin, and the Orpheus Graben.

b) A platform area of basement rocks adjoining (a) which is up to 125 miles (200 km) wide and is overlain by Jurassic and younger sediments up to 2.5 miles (4 km) thick. This platform is called the LaHave platform in the south west, and the Canso ridge in the south east. Its southerly boundary is the 'hinge zone' - a zone of faulted basement blocks which marks a flexure in the crustal rocks.

c) A basinal area seaward of (b) called the Scotian Basin, in which sediments have accumulated up to 7.5 miles (12 km) in thickness. This is the area of greatest potential for oil and gas discoveries (Figure 17).

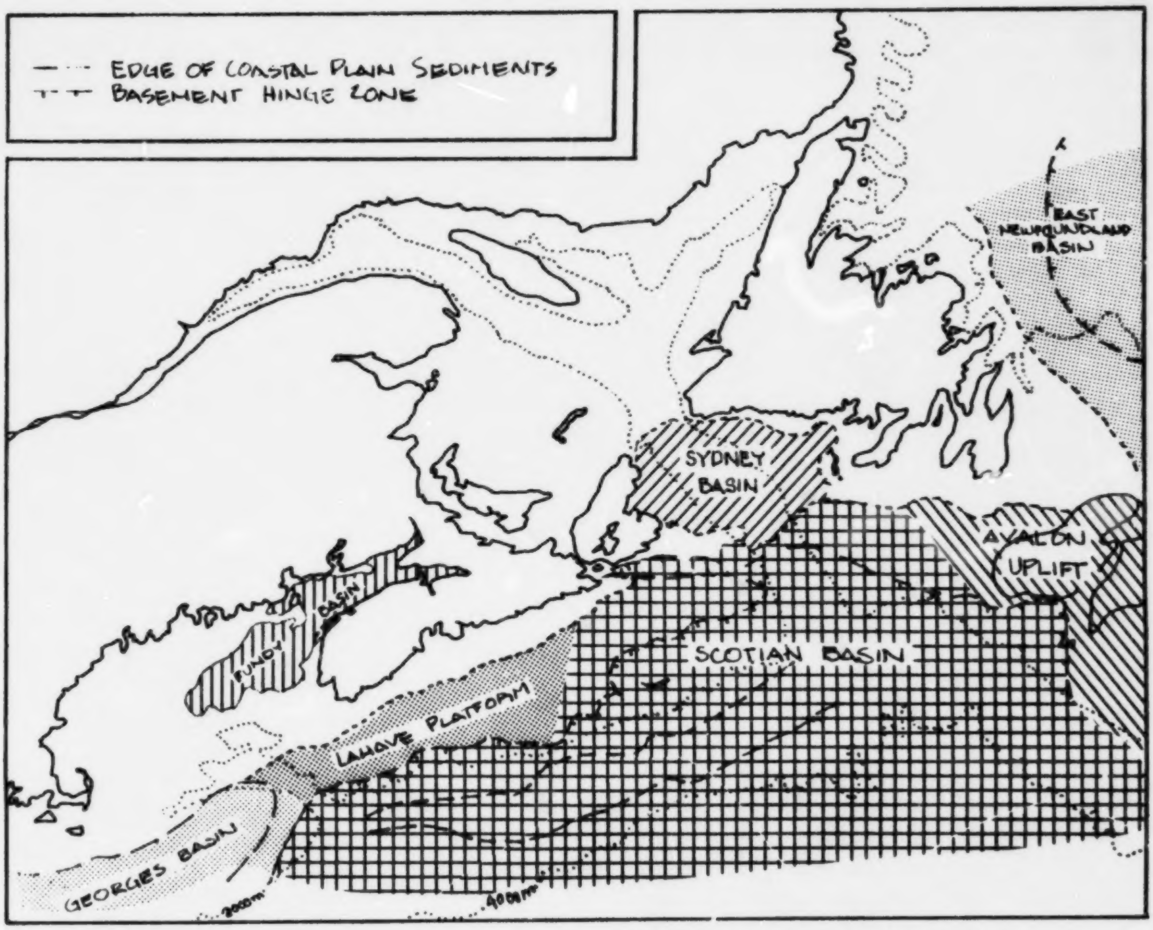

EDGE OF COASTAL PLAIN SEDIMENTS
BASEMENT HINGE ZONE
EAST NEWFOUNDLAND BASIN
SYDNEY BASIN
AVALON UPLIFT
FUNDY BASIN
SCOTIAN BASIN
LAHAVE PLATFORM
GEORGES BASIN
2000m
4000m

Fig. 17. Tectonic elements in the Atlantic Coastal Margin.
Jansa and Wade (1974)

GEOLOGY

Jurassic Salts And Organic Mud

In the Early Jurassic period Nova Scotia was part of the North American continental landmass which was moving northwards away from the equator. About 125 miles (200) km south of the present coastline lay a shallow sea in which salt was being deposited. The climate was still hot. Gradually the shoreline of this ancient sea moved further north, closer to the present coastline. During the Middle and Late Jurassic the sea deepened and the climate became more temperate. Land derived sediments were deposited on top of the salt. These sediments were mainly carbonates and muds containing organic matter from the continental landmass. They were deposited in relatively deep water were well sorted and finely disseminated. Today they represent a potentially good source horizon for oil and/or gas (see Figure 18).

Cretaceous Deltas

The southward retreat of the shoreline during a marine regression in the Early Cretaceous resulted in the development of deltas on top of the Jurassic sediments in the eastern part of the Scotian Basin, near Sable Island. Woody material, which was washed in and buried within the deltaic sands and muds now represent the principal source for the gas reserves being delineated in the Sable Island exploration block. The whole sedimentary sequence was covered by fine muds during the Late Cretaceous, when sea water once more invaded the shelf and created deep water conditions in the basin area.

Recent Deposits

During the last phase of geological development on the Scotian Shelf, sediment banks have been built out along the continental slope. The final veneer of glacial outwash deposits and end moraines was deposited as the Wisconsin ice sheet retreated 12,000 years ago.

OIL AND GAS RESOURCES

There are several critical conditions that determine the hydrocarbon resource potential of an area.

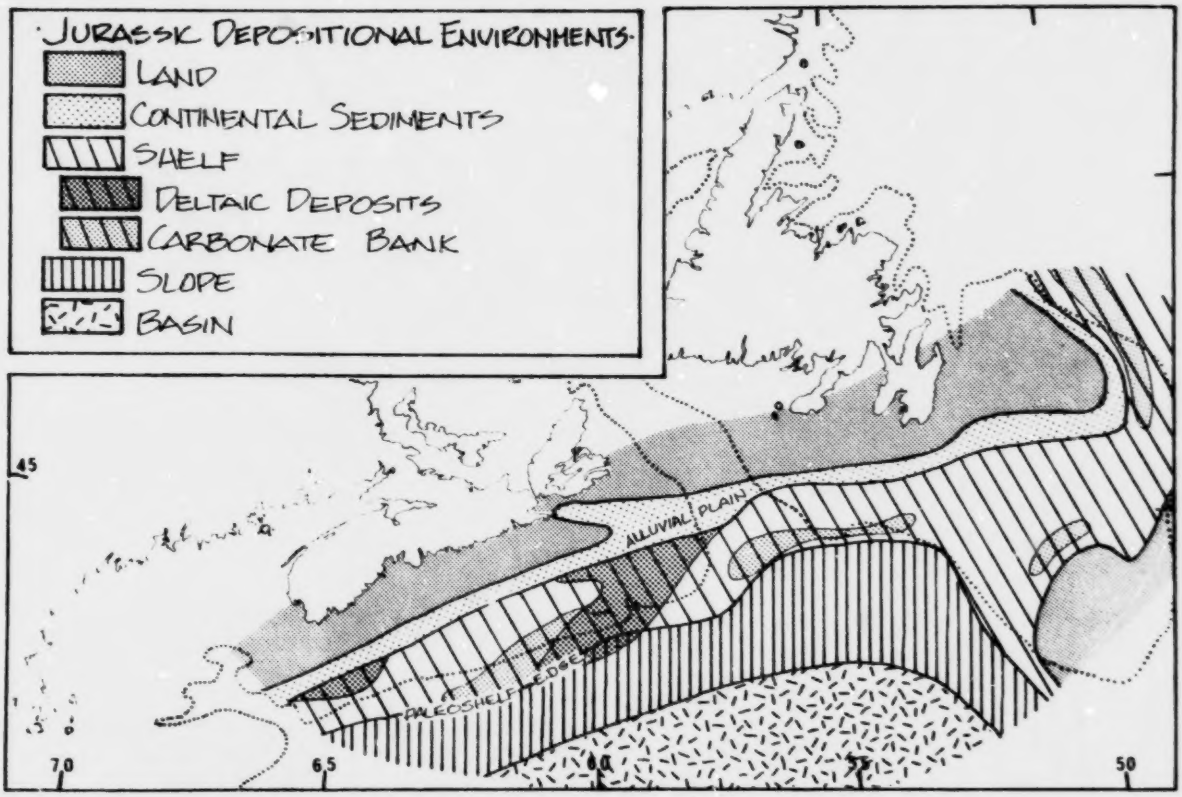

JURASSIC DEPOSITIONAL ENVIRONMENTS
LAND
CONTINENTAL SEDIMENTS
SHELF
DELTAIC DEPOSITS
CARBONATE BANK
SLOPE
BASIN
ALLUVIAL PLAIN
PALEOSHELF EDGE
45
70
65
60
55
50

Fig. 18. Jurassic Depositional Environments.
Jansa and Wade (1974)

1. The source rock at depth must contain adequate organic material of the right type.
2. The source rock must be buried deep enough to ensure that heat and pressure can act upon the material and squeeze out the hydrocarbons. If the pressure and/or temperature is too great, oil may be 'cracked' and gas produced. Some organic material tends to produce gas rather than oil in any event, for example the woody deltaic material. If the pressure and/or temperature is too low the hydrocarbons do not move freely and the source rock is deemed immature.
3. Once mobilized the hydrocarbons must be collected in a reservoir - often a sandstone or reef complex.
4. The reservoir must be capped with an impervious rock which prevents the hydrocarbons from escaping.

THE POTENTIAL OF THE SCOTIAN SHELF

Offshore basins containing thick piles of sediment are now the principal focus of oil exploration activities. Four areas on the east coast of Canada are currently under active exploration, of which the Scotian Shelf is one.

Limitations

The hydrocarbon potential of the Scotian Shelf is now thought to be limited in several ways.

1. The Cretaceous deltaic deposits are immature and tend to be gassy.
2. The deeper Jurassic sediments may represent a better source for oil but may also have been subject to too much heat and/or pressure for the oil to have survived. These sediments are deeply buried and have not been actively drilled to date
3. Reservoir seals are poorly developed.

The Importance of Salt

Most exploration has taken place in areas strongly influenced by the movement of salt. Salt has a low specific gravity and tends to rise through the overlying sediments in large domes or diapirs. This movement causes the roofing strata to bow upwards. Reservoir areas may then be created on the flanks of the domes, with the salt acting as a sealant. Since salt also has a higher thermal conductivity than sediment, it may transfer enough heat to immature sediments to allow the hydrocarbons to mobilize.

In a generalized way the Scotian Shelf is seen as an area of low to moderate potential for oil production, and moderate to good potential for gas.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T28 Offshore Bottom Characteristics

REFERENCES

Jansa and Wade (1974)
Purcell *et al* (1980)

T10 Land-based Economic Deposits

Many naturally occuring rocks, minerals and organic deposits in Nova Scotia have an economic value based upon their use as industrial raw materials, agents in manufacturing processes, or as fuels. They fall into four broad groups: industrial minerals, construction materials, metallic minerals, and energy resources. For a combination of political and economic reasons the last two of these are currently the subject of increasing exploration and evaluation activity.

INDUSTRIAL MINERALS

Origin and Distribution

The most important sources of industrial minerals are the sedimentary rocks of the Carboniferous Basin. These strata yield limestone, dolomite, gypsum, anhydrite, salt, potash, barite, celestite and other minerals which are all quarried or mined actively.

Significant deposits of industrial minerals, are distributed across the entire area covered by rocks of Carboniferous age, but are particularly concentrated in Cumberland, Colchester and Hants counties, and in Cape Breton (N.S. Department of Mines, 1966). Many deposits have not been accurately assessed to date.

Uses

These minerals have a wide range of uses depending to some degree upon their purity. Limestone and dolomite, for instance, may be used in the chemical industry, in metallurgical processes, in agriculture, or in cement making. Gypsum is used in the construction industry to make wall board. Anhydrite is used in cement and as a soil conditioner. Salt is used for fish curing, ice removal, in chemical processes, and as a household commodity. Potash has a variety of uses, including the manufacture of fertilizers, for brewing, ceramics, glassmaking, paints, and textiles. Celestite and other minerals are used predominantly in the chemical industry. The local demand for barite has risen recently since it is a major constituent of the drilling mud used in oil exploration. Silica sand is used in the manufacture of fibreglass insulation and glassware.

CONSTRUCTION MATERIALS

Source and Distribution

The most useful sand and gravel deposits are composed of the more durable rocks such as granites and quartzites. Such deposits are restricted to the flanks of the Avalon Uplands (region 300) and the northern slopes of the Atlantic Interior. Where naturally occurring glacial sand and gravel deposits are scarce, particularly in the Atlantic Interior (region 400) and Atlantic Coast (region 800) crushed rock is produced from fine-grained Meguma quartzites and from granite. Beach sand has, in the past, been added to crushed rock to make concrete aggregate. Sandstone is quarried from Carboniferous strata (region 500), and granite from the major plutons in the Atlantic Interior (district 450). Clay is restricted to Cretaceous deposits in the Musquodoboit and Shubenacadie Valleys (unit 511).

Uses

Sand, gravel and crushed rock are needed as aggregate for road, pipeline and building construction, and also in concrete. Granite, sandstone and other decorative rocks are used for facing walls, as tombstones and also as building blocks. Clay is the raw material used to make bricks and tiles.

METALLIC MINERALS

Origin and Distribution

Some metals are introduced into the Earth's crust from the mantle during the process of magma generation, ascent and intrusion. They are carried first by the molten rock and then by the residual fluid into the surrounding rock.

When the igneous rock and mineralized veins are exposed and eroded the metals are redistributed in the receiving sedimentary basin. Later, when these sediments are buried, compacted and metamorphosed, percolating fluids once again pick up and carry the metals to localities where pressure, temperature or chemical conditions cause them to be reprecipitated as minerals.

Metallic minerals are found in igneous, sedimentary and metamorphic rocks. Within a given series of strata which have a common history, minerals are found in predictable locations and predictable combinations. In the Meguma series of central Nova Scotia, for example, gold is found in association with quartz and arsenopyrite in the crest of large scale folds.

In the following section the most common mineral associations are listed for the different geological areas of the province. Figure 19 shows the location of gold districts and both active and inactive mines and quarries.

MINERAL ASSOCIATIONS

Southern Mainland

Meguma metallic minerals in the Meguma rocks are commonly found in veins with the following metal associations:

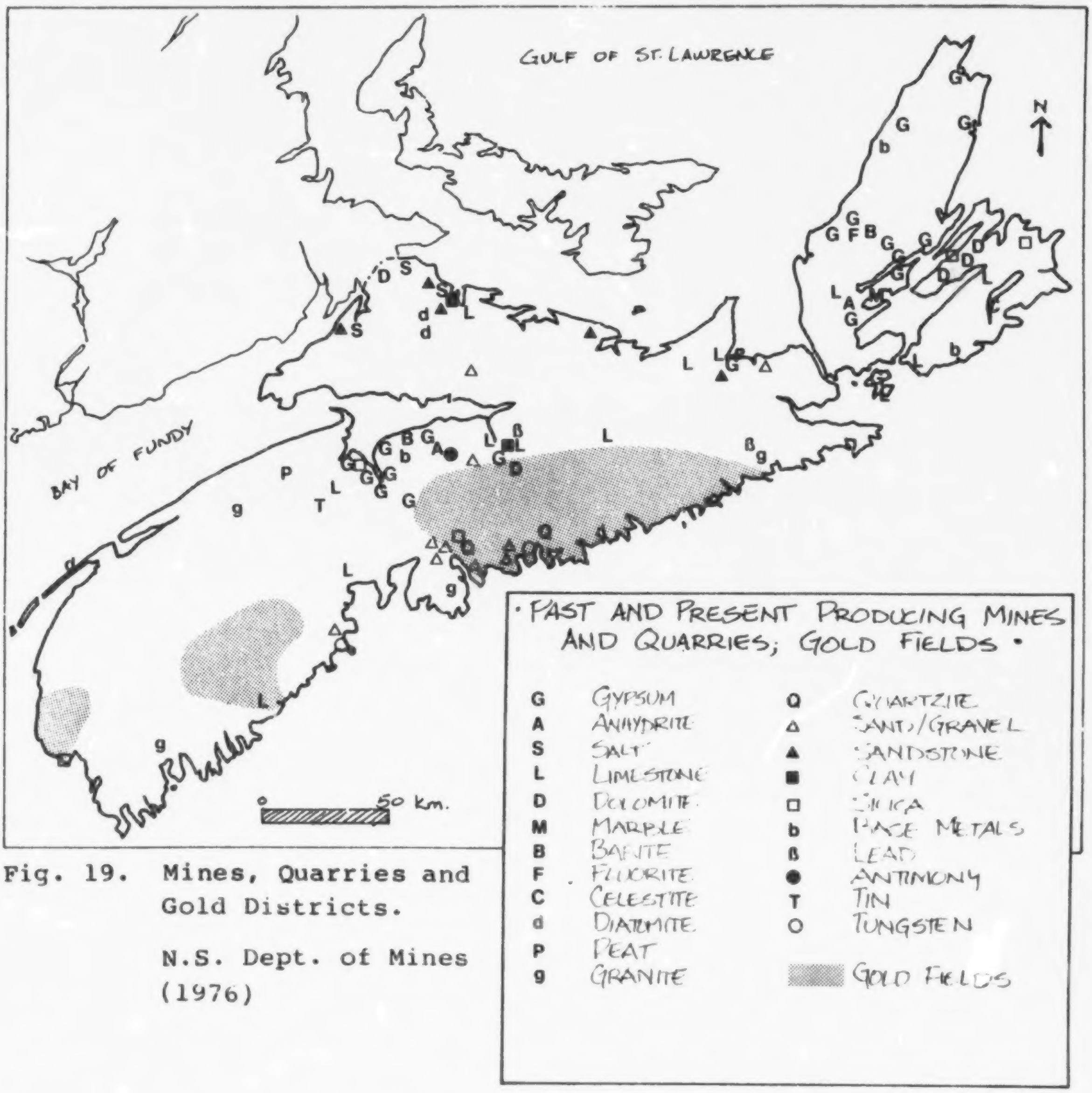
Gold, arsenic and quartz; tungsten and antimony; iron and manganese; tin.

Granite. The metallic minerals again are found predominantly in veins. The associations are: tin, tungsten and uranium; gold and quartz. Tin also occurs dispersed with other metallic minerals as a precipitate throughout crushed or gravelly rock. The large tin deposit at East Kemptville is of this type.

Carboniferous Strata. Copper, lead and zinc minerals are found in carbonate-bearing rocks in the Carboniferous strata. They occur within and are confined to certain strata; they are therefore called stratiform-stratabound deposits. In two localities, Salmon River and Gays River, lead-zinc deposits have been assessed as economically exploitable. The Salmon River mine is no longer operating, and the Gays River mine has also been closed owing to problems with water seepage and poor ore grades.

Northern Mainland

Metallic mineral deposits in the northern mainland are predominantly of the copper-lead-zinc type found to the south, but in these deposits copper is more prevalent.


GULF OF ST. LAWRENCE
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PAST AND PRESENT PRODUCING MINES AND QUARRIES; GOLD FIELDS
G GYPSUM
A ANHYDRITE
S SALT
L LIMESTONE
D DOLOMITE
M MARBLE
B BARITE
F FLUORITE
C CELESTITE
d DIATOMITE
P PEAT
g GRANITE
Q QUARTZITE
△ SAND/GRAVEL
▲ SANDSTONE
■ CLAY
□ SILICA
b BASE METALS
ß LEAD
● ANTIMONY
T TIN
O TUNGSTEN
▨ GOLD FIELDS

Fig. 19. Mines, Quarries and Gold Districts.

N.S. Dept. of Mines (1976)

Cape Breton The economic geology of Cape Breton is distinctly different from the mainland. The calcareous rocks of the Precambrian George River Group contain assemblages of zinc, tungsten, copper, molybdenum and iron, which are quite unlike those on the mainland. Copper and molybdenum are also found in veins associated with the Precambrian and Devonian granites. Another class of deposit are produced by replacement of certain elements in a rock by others via the action of circulating fluids. These also have copper-lead mineral combinations, but are unlike those associated with carbonate rocks.

ORGANIC DEPOSITS

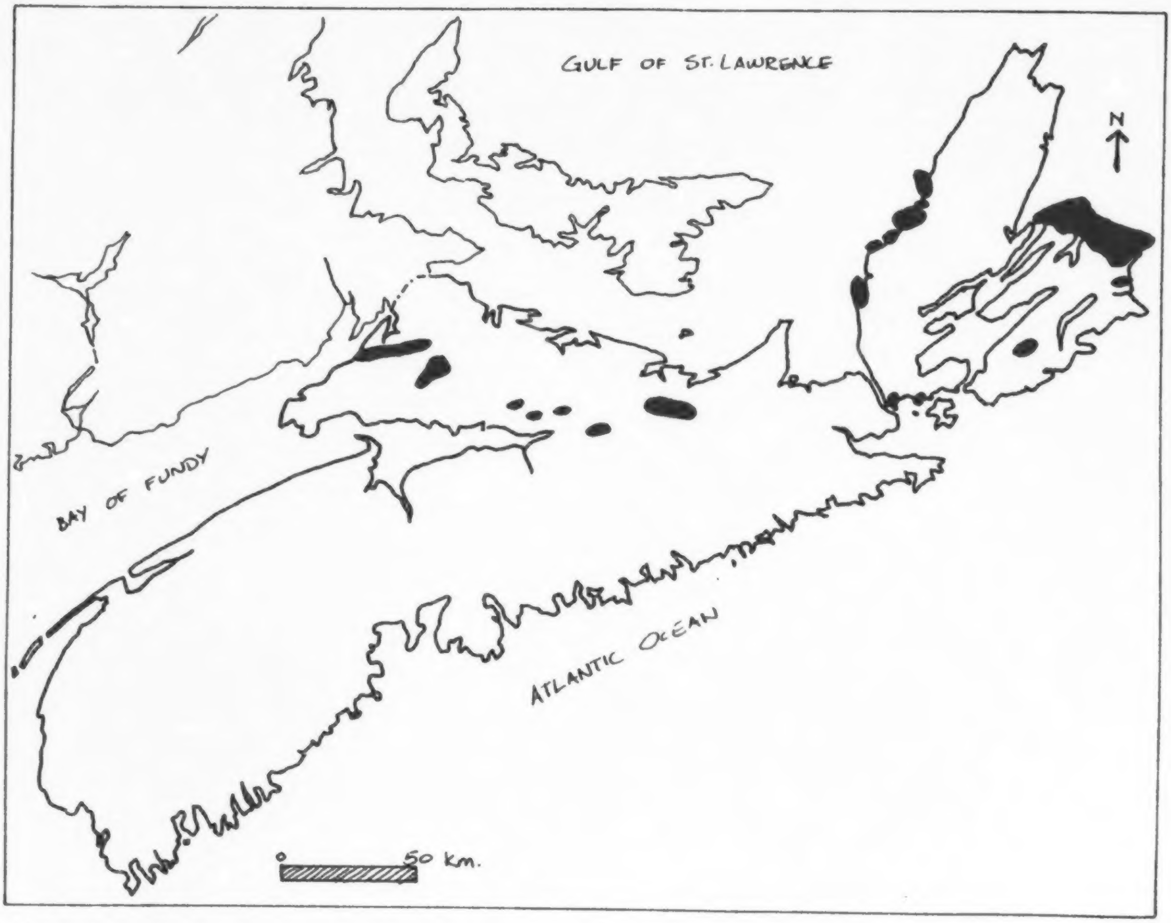
As energy security considerations compel careful evaluation of provincial energy resources, much attention is now being paid to Nova Scotia's coal, gas, oil and peat reserves.

Coal The major coal fields in Nova Scotia are shown in Figure 20. In most of these economically recoverable reserves are now being recalculated following both drilling programs (Cumberland, Pictou and Sydney), and assessment of such secondary sources as mine dumps and the support pillars in old workings (Pictou).

Coal and Gas The feasibility of recovering methane from coal fields is currently being assessed in two areas, Pictou and Sydney. In Pictou methane would be pumped directly from the strata, whereas in Sydney it would be removed from existing mine vents.

Oil Seismic exploration and drilling is currently underway in the northern mainland section of the Carboniferous Basin, in order to determine the oil and gas bearing potential of these strata.

Peat The Nova Scotia Department of Mines and Energy is currently undertaking an assessment of the peat deposits in Nova Scotia. This project, initiated in 1980, will take at least six years to complete. It has been estimated that Nova Scotia has approximately 575,000 acres (230,000 hectares) of peatland.


GULF OF ST. LAWRENCE
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BAY OF FUNDY
ATLANTIC OCEAN
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50 km.

Fig. 20. Major Coal Fields.

N.S. Dept. of Mines (1976)

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T4 The Avalon and Meguma Zones, T5 Granite in Nova Scotia, T6 The Carboniferous Basin: An Inland Sea, T7 The Nova Scotian Desert, T8 The Triassic Basalts and Continental Rifting, T9 Offshore Geology and Resources.

REFERENCES

Keppie (1979)
N.S. Dept. of Mines (1966, 1976)
N.S. Dept. of Mines and Energy (1981) Exploration Licenses

LANDSCAPE DEVELOPMENT

T11 Development of the Ancient Landscape

Landscape is the product of the geology and structure of the terrain, the erosive processes acting upon it, and the length of time over which they act. In Nova Scotia there are a variety of igneous, metamorphic and sedimentary formations which have been exposed to desert, temperate and glacial conditions over 140 million years. This long erosive history can be divided into three parts: the development of a planation surface (essentially complete by the Cretaceous period); uplift, tilting and redissection of this plain during the Tertiary; and glaciation during the Pleistocene epoch. Glacial activity in the province is described in T13 Glaciation; elements of the physiography attributable to the other two periods of erosion are described below.

THE CRETACEOUS PLANATION SURFACE

The first phase in the formation of the landscape was the development of an erosion surface during the period prior to the Early Tertiary, about 60 million years ago. At that time Nova Scotia may have looked like a relatively uniform, flat plain almost at sea level. To the north the plain extended well into New Brunswick; to the south it stretched beyond the present coastline and out over at least part of today's continental shelf. The climate at that time was predominantly hot and dry, and erosion was subaerial, with wind abrasion, flash flooding and diurnal expansion and contraction of exposed surfaces being the principal weathering agents.

The surface of the plain cut across some very resistant rocks, the granite and quartzite of the Atlantic Interior, and the old metamorphic rocks of the Cobequid Hills, Pictou-Antigonish Highlands and the Cape Breton Highlands. Although the surface was broadly even, part of the northern plateau of Cape Breton, the granite knolls south of Kentville, and Mount Aspotogan in Lunenburg County all stood above the erosion surface.

The planation surface was uplifted during Tertiary times and has since been dissected so that little remains of its original uniformity. None the less, it still contributes a great deal to the character of the Nova Scotian landscape. The even horizon line and relatively modest maximum elevations can both be attributed to this early levelling (Figure 21).

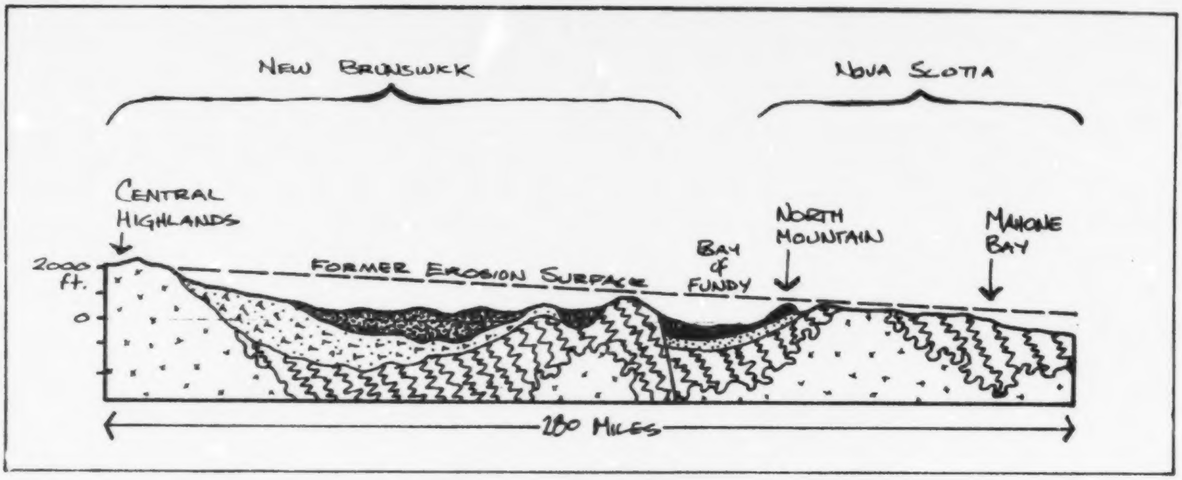


Fig. 21. Tilted Cretaceous Planation Surface
Cooke, H.B.S. (1972)

THE TERTIARY UPLIFT

Towards the end of the Cretaceous period the continental shelf subsided and thick sedimentary deposits began to accumulate offshore. At that time erosion on land was very slow, and only very fine sediments were removed from the flat surface.

During the Tertiary, the crustal block of which Nova Scotia was a part was uplifted and tilted; sea level dropped to at least 650 feet (200 m) below the present level and much of the continental shelf was exposed once again. Vigorous erosion commenced. The soft, unmetamorphosed post-Devonian sediments were stripped off exposing an ancient landscape of resistant ridges (for example, the Rawdon Hills and Wittenburg Mountain, district 420), old hard blocks such as the Creignish Mountains of Cape Breton (region 300), and old buried river valleys (for example, parts of the Musquodoboit Valley and the East River Valley). Drainage systems which had formed on the tilted surface were further excavated and entrenched. The Bras d'Or Lake was deepened and the Gulf of St. Lawrence shelf area became dissected by river valleys. Old coastal features were re-exposed, for example the coastal embayments of Mahone Bay and St. Margarets Bay (district 460) which originally

formed during the Carboniferous period. The river system which had formed west of Cape Split in the Bay of Fundy became further enlarged at this time and the Minas Basin and Chignecto embayments began to develop.
On the Scotian Shelf a relatively level plain was dissected into hills and valleys, which later became banks and channels during the subsequent rise of sea level.

The rate at which this erosion took place was closely controlled by the geology. The hard igneous and metamorphic rocks of northern mainland Nova Scotia, Cape Breton and the Southern Uplands were not worn down appreciably, and became more prominent in the landscape as the surrounding soft sediments were removed around them. Lowlands formed from the Carboniferous strata of limestone, gypsum, shales, and coal measures. The coarse gritty Horton sands were left as resistant shoulders against older, hard blocks such as the Pictou-Antigonish highlands. The soft Early Triassic deposits south of North Mountain were easily washed out by rivers flowing through the Annapolis Valley and St. Marys Bay (region 600).

Where hard and soft rocks came into contact through faulting, differential erosion left steep escarpments such as those on the west face of Aspy Bay and Cape North, and the north side of the Minas Basin.

MARINE INCURSION

Sometime in the late tertiary the sea level rose, relative to the land and the old coastline was drowned. Distinctive coastal features, such as the Bay of Fundy, Bras d'Or Lake, Canso Strait and St. Marys Bay, were inundated together with other smaller river estuaries and coastal embayments. The essential character of the landscape and coastline of Nova Scotia, reflecting its geological and erosional history, was established at this point and was only modified by the glaciation which came later.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T9 Offshore Geology and Resources

REFERENCES

Cooke (1972)
Goldthwait (1924)
Roland (1982)

T12 Tertiary Drainage Patterns

The drainage patterns across Nova Scotia have developed almost entirely since the Tertiary and are closely tied to the geology. They are the response of water flowing down an inclined plain to the structure and composition of the underlying rocks. Water follows lines of weakness such as soft strata, joints or faults, and establishes a characteristic drainage pattern. This is continuously modified until the river develops a profile which is in equilibrium with both the regional slope and the geology of its drainage basin.

In Nova Scotia drainage patterns diverge from their ideal form because of three influences: the Pleistocene glaciation which scoured the surface of the province and then dumped unsorted rock debris upon it; fluctuations in sea level; and ancient river channels which developed before the Tertiary and are now superimposed upon the terrain. All these factors are reviewed in more detail below.

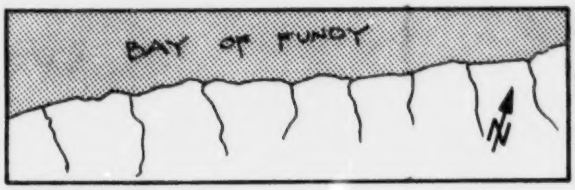
INFLUENCES ON THE FORMATION OF DRAINAGE PATTERNS

Rock Type

The erodability, permeability and jointing of the bedrock determine both the proportion of water that is retained on the surface, and how runoff is channelled. Impermeable, poorly jointed rocks such as granite, greywacke and slate retain most of the water on the surface in a disorganized series of streams, lakes and bogs. This is called deranged drainage (Figure 22) and can be seen on South Mountain and across most of southern Nova Scotia.

Permeable, well jointed rocks such as limestone, sandstone and gypsum allow substantial infiltration, they have few lakes, and channel surface runoff along joint lines and the bedding trend. The product is rectangular or trellised drainage. This is well developed in the Carboniferous sandstones and salts of central and northern mainland Nova Scotia and Cape Breton.

Unconsolidated sediments with an even slope and also evenly resistant rocks with moderate to


BAY OF FUNDY
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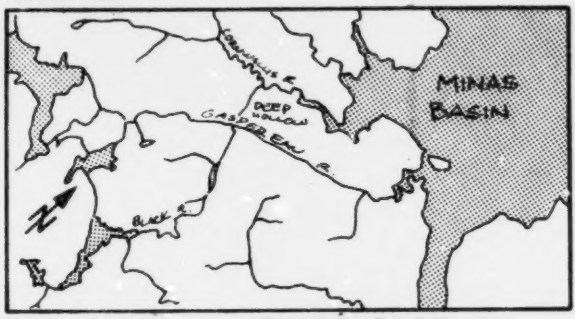
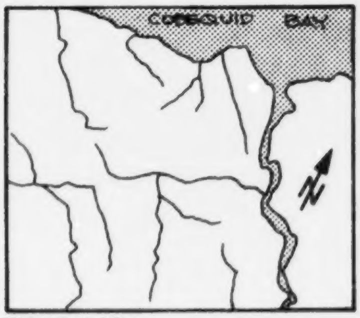
PARALLEL
District 720

Fig. 22a) Classical Drainage Patterns from Nova Scotia. From 1:50,000 map of N.S., Department of Energy, Mines and Resources, 1974.


CORNWALLIS R.
DEEP HOLLOW
GASPEREAU R.
MINAS BASIN
BLACK R.
N

DERANGED and RIVER CAPTURE

River Capture: the Black River formerly drained through Deep Hollow into the Cornwallis River. The more vigorous Gaspereau River has diverted the Black River at White Rock. Black River is deranged drainage pattern, now extensively dammed for hydro electric power.


COBEQUID BAY
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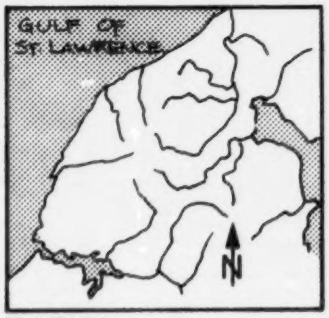
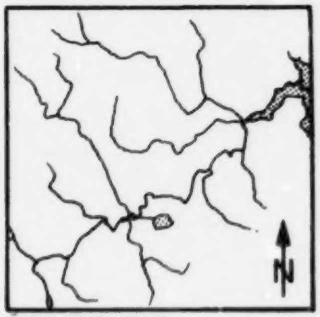
TRELLIS
District 510


GULF OF ST LAWRENCE
N

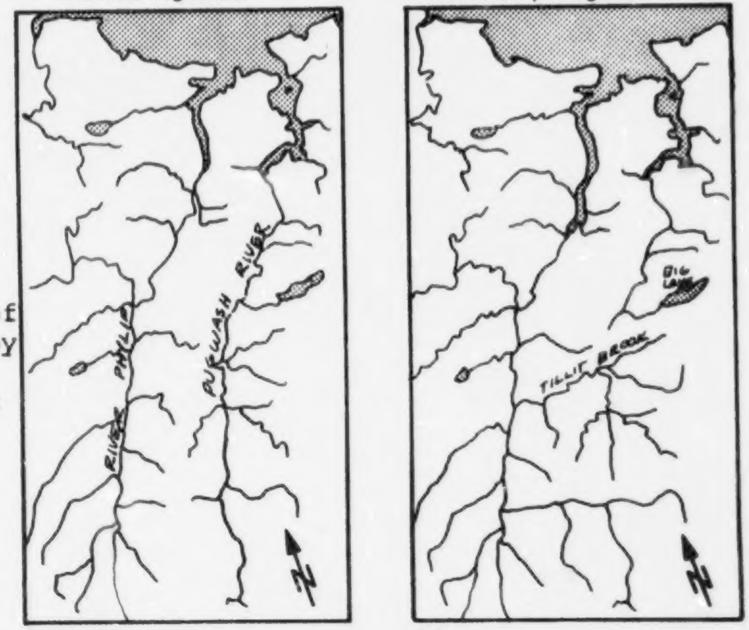
RADIAL
Mabou Highlands



DENDRITIC
West River, Antigonish

Fig. 22b) Example of River Capture.

River Capture of former headwaters of the Pugwash River by the River Philip. Both rivers exhibit a classical trellised pattern reflecting the east-west folds in the sandstone bedrock, District 520.


RIVER PHILIP
PUGWASH RIVER
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BIG LAKE
TILLIT BROOK
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Before After

high relief, develop dendritic drainage patterns. This is exhibited by the soft Triassic sediments in the Annapolis Valley, around the Minas Basin, and the highland areas of the Cobequids, Pictou-Antigonish and Cape Breton.

Structure and slope

In tilted or folded strata where hard and soft rocks are interbedded fluvial erosion tends to produce a Ridge-and-Valley topography in which the valleys, and therefore the streams that flow in them, are parallel to one another. If the regional slope of the land surface is parallel to the axes of the folds a parallel drainage pattern may develop becoming rectangular in places where the ridges are cross cut. If the fold and slope directions are opposed the pattern is generally strongly rectangular or even trellised. While there are no good examples of this type of parallel drainage in Nova Scotia, structurally controlled rectangular patterns are well developed on the Cumberland-Pictou plain, north and east of the Cobequid Highlands.

Faults also add a linearity to drainage patterns since the rubbly material along their zone of movement is easily removed by flowing water. This fault control is a feature of the West St. Marys River and several nearby river valleys for example, Tangier River and West Sheet Harbour River in Halifax County.

Parallel drainage is also characteristic of areas where streams cascade down a steep slope and do not branch appreciably before entering the sea, for example the streams rising on North Mountain and flowing down to the Bay of Fundy. When the highland area is rounded the streams drain down the slopes in a radial pattern. The Cape Breton Highlands and Mabou Highlands both exhibit a modified radial drainage pattern.

Ice Scouring

The scouring action of ice overprints a lineation on the bedrock which is parallel to the direction of ice flow. This linearity may change the drainage pattern locally and override the control normally imposed by the bedrock. In Nova Scotia this influence is locally manifest in the alteration of a dendritic pattern to one approaching parallel or rectangular, for example, along the Western Shore, Eastern Shore, and in Southern Cape Breton.

Deposition

In contrast to the linearity imposed by scouring, glacial deposits tend to block established channels and disorganize the drainage patterns. If the deposits had an even thickness and distribution a dendritic pattern may be established. However, in Nova Scotia glacial deposits tend to be very uneven and the drainage is deranged. The influence of glacial deposits is well displayed in southern Cape Breton where thick glacial deposits on the flat bedrock have established a new regional slope. The Mira River, which once flowed southwards, now flows eastwards (district 870).

Sea Level Change

In a stable environment rivers and streams establish a concave profile from source to mouth which is in equilibrium with the relief, geology and the distance from the headwaters to the estuary. The profile is established above a 'base level' which is ultimately sea level. When sea level changes the profile is no longer in equilibrium. If sea level falls stream energy increases and it starts to cut down actively and erode incised valleys. If sea level rises the streams become more sluggish and deposit material in their lower reaches. On the Atlantic Coast, since sea level is currently rising at a rate of about 6 inches (15 cm) a century, streams and rivers are more liable to deposit than erode near the estuary. They are thus less able to cut through and redistribute glacial material than they would if the base level were constant. Rising sea level thus reinforces the disorganizing effect on drainage patterns imposed by glacial deposition.

Relics of an Ancient Drainage System

Some features in the fluvial landscape of Nova Scotia do not appear to be the product of either erosion since the Tertiary or of glaciation. For example, the Musquodoboit River flows through a valley cut directly across the Granite Ridge (district 450). The Cobequid Highlands are also transected by two valleys, the Folly Gap and the Parrsboro Gap, which were cut by rivers much larger than those which occupy them today.

Several lines of evidence indicate that these are relics of a pre-Tertiary drainage system which developed at a higher level above the present erosion surface on a plain which was tilted towards New Brunswick. As the rivers cut down through the overlying strata they became superimposed upon the rocks at the present level of erosion. During the Tertiary the original direction of drainage (to the north) shifted 180 degrees and these rivers established a southerly flow, abandoning part of their old channels. Subsequent erosion and the disruption of glaciation has removed all but a few ghosts of these systems. This remaining evidence can be used to attempt a broad, speculative reconstruction of the ancient drainage network. For a fuller discussion see Roland (1982).

Watershed boundaries

Watershed boundaries are continuously changing as rivers which drain areas of weaker rocks erode backwards and establish progressively larger drainage areas at the expense of neighbouring streams. For instance, in the interior of eastern mainland Nova Scotia many rivers which flow southwards to the Atlantic across the Atlantic Interior have lost part of their drainage areas to the West St. Marys River. Similarly the watershed of Country Harbour River has been reduced by the westerly extension of the South River and Salmon River systems which flow into St. Georges Bay and Chedabucto Bay respectively (district 570).

River Capture

There are numerous examples of river capture across the province where streams or major rivers have been directed into the upper reaches of an adjacent watershed. A wind gap or dry valley is then left along the original course of the stream, and the remaining stream is undersized for the valley in which it flows. An excellent example of river capture can be seen in the headwaters of River Philip, Cumberland County. Several streams which once flowed down a fault into the Pugwash River have been diverted to the West and now flow into

River Philip, parallel to their original course. Similarly the Gaspereau River has intercepted the Black River at White Rock, Kings County, leaving an underfit stream to occupy the lower portion of the valley known as Deep Hollow.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T11 Development of the Ancient Landscape, T13 Glaciation, T25 Sea Level Change, T29 General Hydrology

REFERENCES

Bloom (1969)
Cooke (1972)
Roland (1982)

T13 Glaciation

The major features of the landscape of Nova Scotia, the overall relief, the distribution of highland, upland and lowland areas, are all the product of its long geological history. The minor features, the final rounding of surface features, the alignment of surface lineations, surficial deposits and sea level changes, are the product of glacial activity during the Pleistocene Period.

The last phase of glaciation ended about 10,000 years ago and left behind an unconsolidated mantle of sediment. On this substrate drainage patterns were re-established and soils developed. In this topic the character and distribution of glacial deposits are covered in some detail in order to provide a basis for later topics, particularly those found in the Habitat section.

THE GLACIAL HISTORY OF NOVA SCOTIA

There were four main glacial episodes during the Pleistocene period in North America, the Nebraskan, the Kansan, the Illinoian and the Wisconsin. Each occupied a period of about 100,000 years and was separated from the others by interglacial intervals during which the ice temporarily receded. The present relatively warm, ice-free period may mark the end of the Ice Age but it could also be an interglacial or even an interstadial interval - a pause before the next advance.

Each major glacial advance, by its nature, tends to destroy evidence of previous glaciations. The glacial deposits and features in Nova Scotia are therefore almost all of Wisconsin age. The earliest identifiable and dated deposits are shown in figure 43. The raised marine platform on which these deposits rest is thought to have been formed during the interglacial period (the Sangamon) preceding this last glaciation. During the Sangamon interglacial, widespread melting caused a rise of sea level to several feet above the present level. The position of sea level at that time is marked by a wave-cut platform which rings Cape Breton and is also exposed on the western shore of mainland Nova Scotia (district 820).

The main events of the Wisconsin glaciation have been interpreted from the deposits resting on top of this marine platform and are summarized in the following sections.

Local ice caps

Following the Sangamon interglacial, ice caps developed over local centres. One was located in the Atlantic Interior and another to the west of Cape Breton. These spread thin deposits (tills) derived from local rocks over much of the southwestern mainland and parts of Cape Breton.

Major inundation

After the initial advance Nova Scotia was inundated by a flood of ice from New Brunswick. This ice filled the Bay of Fundy and carried red sediments south and southeast over the Southern Uplands and Carboniferous lowlands. Some ice was apparently deflected by the Cobequid Mountains and travelled more directly eastwards, depositing Cobequid-type boulders and stones in the area of Pictou and Pictou Island. There is evidence that the ice which covered at least the southern part of Cape Breton at this time came from the south, presumably from an ice centre located on the Scotian Shelf (Grant, 1971).

The major glacial advance from the north established much of the drumlin topography in southern and eastern Nova Scotia. It also produced the north-south and northwest-southeast alignment of geomorphological features on the mainland. The northeast-southwest lineation across the lowlands of Cape Breton may be the product of ice flow from the south.

From Cape Breton the ice was drawn into the St. Lawrence channel. Elsewhere in Nova Scotia it advanced across the continental shelf and established a line of end moraines 20-25 miles (30-40 km) offshore. These extend as a series of lobes and ridges for 525 miles (850 km) from the Laurentian Channel to the Gulf of Maine (Figure 23).

In the middle of the Wisconsin glaciation, about 50,000 years ago, there was a warming period. The ice flow from the north and the Scotian Shelf was cut off, the sea inundated the Bay of Fundy, and the ice melted back to local centres.

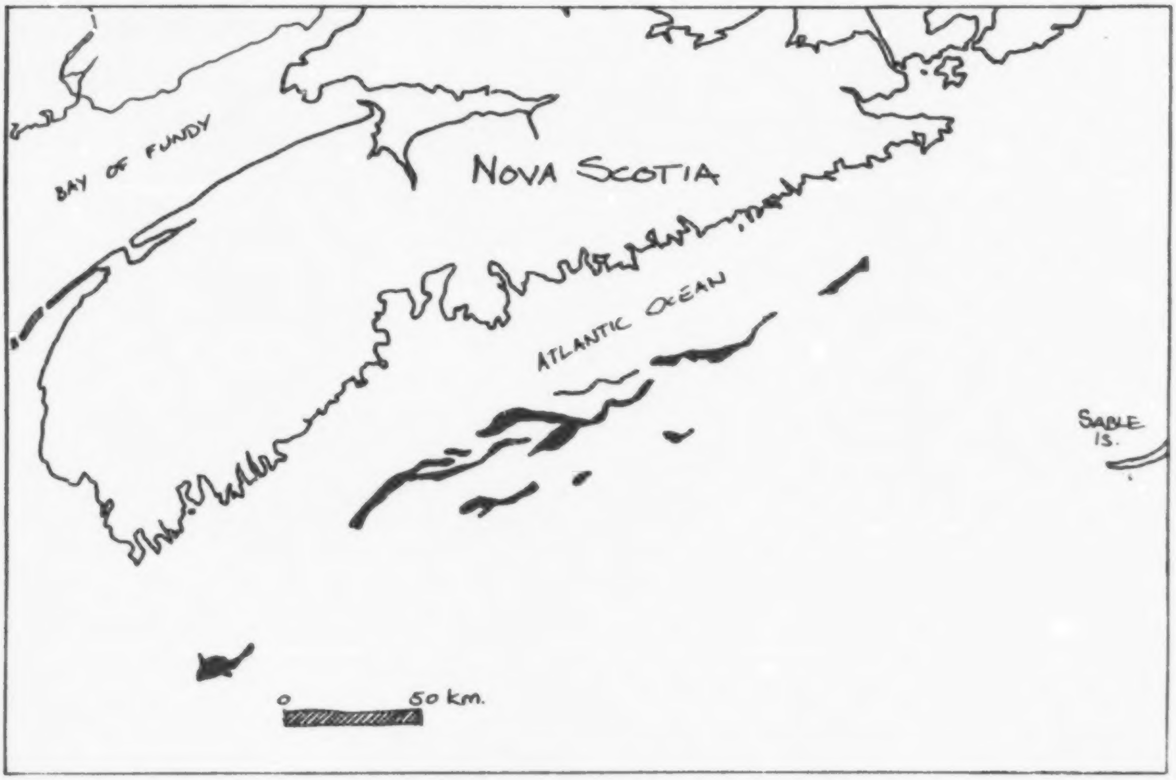


Fig. 23. End Moraines, Wisconsin Glaciation (about 100,000 years B.P.)
- King, MacLean and Drapeau (1972)

Final Advances

The final advances, two or three in number, were from small residual centres left behind on areas of high ground, notably South Mountain (district 450), the Pictou-Antigonish Highlands (unit 312) and northern Cape Breton (region 100). These small ice caps produced glaciers which flowed outwards in a radial pattern. None of the advances in the late Wisconsin were as strong as those before and they became progressively weaker until the ice caps finally disappeared from Nova Scotia about 10-12,000 years ago.

Rebound And Sea Level Rise

Following the removal of the ice burden, the land surface rebounded in proportion to the former degree of loading. Since the ice had decreased in thickness from north to south over Nova Scotia there was a parallel pattern of rebound. Almost simultaneously sea level rose as water was released from the ice caps to the north. In the Bay of Fundy area uplift soon exceeded the rise in sea level and the coastline became raised leaving strandlines several metres above the present high tide mark; good examples can be seen in the Advocate Harbour area. Around Yarmouth the uplift and sea level rise were about equal leaving the coastal features in the same position relative to the sea. In the southern parts of the province from Shelburne county to Guysborough county there was less crustal rebound and the coastline was drowned as the sea moved landwards across the continental shelf.

ASSOCIATED TOPICS

T11 Development of the Ancient Landscape, T25 Sea Level Change

REFERENCES

See Topic 14 Deglaciation and Glacial Deposits

T14 Deglaciation and Glacial Deposits

Nova Scotia is blanketed with a veneer of glacial deposits of varying thickness and form. They were generated by the action of the ice as it scoured, abraded and plucked at the bedrock during its advance across country. The texture of this material (its clay, sand and stone content) reflects the physical properties of the parent bedrock, particularly hardness. Slate, for instance, is fairly easily ground down to clay, and sandstone is reduced to sand, but granite, quartzite and other hard crystalline rocks tend to remain as pebbles and angular stones.

The spatial relationship of the deposit to the parent rock and also its form are determined by several factors:

- the direction of ice movement
- the position of the material underneath or within the ice
- the flow characteristics of the ice mass
- the agent of deposition, i.e. the ice itself, meltwater or wind.

ICE FORMED DEPOSITS

Ground Moraine or Till

Till is the general name given to the material scraped off or ground down from the bedrock. Ground moraine is the till at the base of the ice that is left behind, more or less in place, like a mantle over the previously ice-covered landscape. It is often a structureless, unstratified deposit, but in some places consists of a lower compacted, smeared and relatively impervious layer known as basal till. Above the basal till looser, sometimes sorted material known as ablation till is found.

Ground moraine usually reflects the character of the underlying rocks more directly than other glacial deposits. It is, for instance, likely to be fairly thin and with a high clay content over slates, very stony and often absent altogether over granite, and thick and loamy over soft lowland strata. The stone content is generally high, but variable.

The thickness of the ground moraine cover varies considerably across the province. In general, the thinnest deposits are found on high ground and over resistant rocks, whereas the thickest are in lowland areas and local depressions. The upper surface of the Cobequid Mountains (district 310) and Cape Breton Highlands (region 100 and district 210) have very little glacial cover, while Cumberland County, Hants County and the lowlands of Cape Breton have deposits tens of metres thick (region 500). On the mainland glacial deposits tend to thicken southwards and coastal sections frequently show deposits which are 30 feet (10 m) or more in thickness.

At a smaller scale, the distribution of moraine reflects the way an ice mass responds to the underlying morphology. Local high areas may be swept clear, for example, Mount Uniacke and Halifax Airport, and the surrounding low spots filled in, for example, Miller Lake area (districts 410 and 430).

The drainage characteristics of ground moraine are determined by its thickness, its clay/sand/stone composition, and the permeability of the underlying bedrock.

Drumlins

Glacial till is often moulded into specially shaped hills called drumlins. These are frequently 50 to 100 feet (15 to 30 m) high, and may be more than a kilometre in length. Seen from above they are generally egg-shaped and aligned parallel to the axis of ice movement with the pointed end indicating the downstream direction of flow.

Texturally drumlin deposits range from sand to clay loam. They are not usually stratified in the strict sense, but may show a colour and textural variation from bottom to top as locally derived material is overlain by other material carried at a higher level in the ice. Drumlins typically contain scattered stones and boulders of various sizes; the deposits are generally uncompacted, well drained and easily eroded.

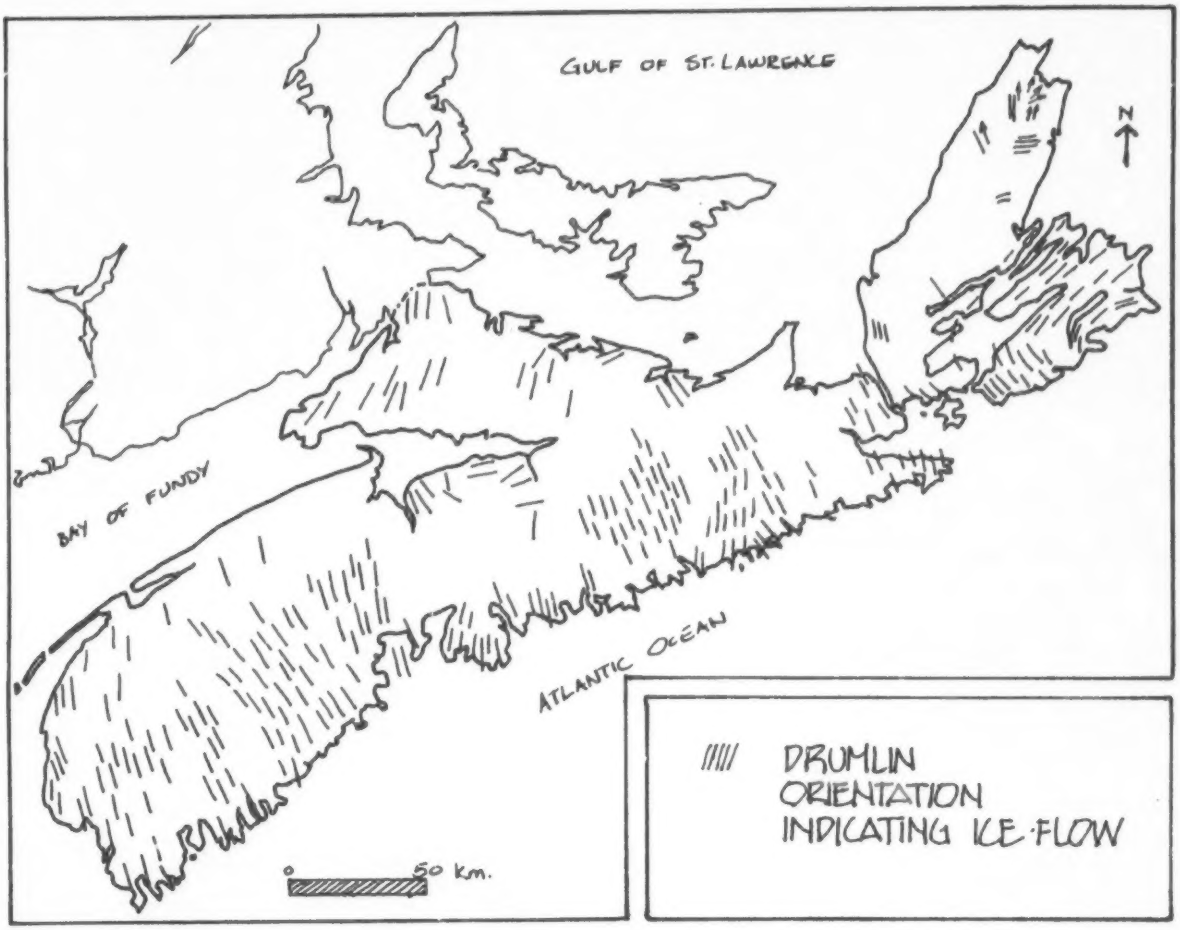
Drumlins seem to have a relatively high buffering capacity, which may result from the inclusion of sediment from the carbonate-rich rocks of the Carboniferous lowlands.

Drumlins are typically found in swarms in the Atlantic Interior and Coast (districts 430 and 830) and Cape Breton (district 870) where the heavily laden ice moved across level areas or down slope. Most are associated with slate strata and are generally scarce once a granite or quartzite boundary has been crossed. In areas where slates and quartzites are interbanded, drumlin fields may cross the quartzite area, but do not seem to incorporate much new material. The association of drumlins with slate areas is less clearly marked in the Halifax-Guysborough area than in southwestern Nova Scotia.

'Red' drumlins are found throughout the Atlantic Interior and along the Atlantic Coast. These distinctive landscape features are formed from materials carried from the Carboniferous lowlands to the north. Red drumlins often occur together; the greatest concentration is in Lunenburg County but they may also be seen north and east of Halifax Harbour and in isolated localities in Halifax and Guysborough Counties. On soil maps these red drumlins are Wolfville soils. By contrast drumlins formed from local slates are 'grey' in appearance. A few isolated drumlins composed of predominantly granite or quartzite rocks are found in south-west Nova Scotia.

Erratics

In a glacial landscape it is common to find large rocks or boulders resting in areas far distant from their source. The direction in which these lie relative to their parent rocks provides valuable evidence of the direction of movement of ice masses. Cobequid-type stones, for instance, are rarely found in the Carboniferous lowlands to the north but are common to the south and form a large proportion of the rocks in the bed of the Salmon River at Truro, near Pictou and on Pictou Island. Similarly igneous rocks from the Creignish Hills in Cape Breton are found to the east near Sydney. In western Nova Scotia granite and basalt are found in a wide area south of their respective outcrops on South Mountain and North Mountain.


GULF OF ST. LAWRENCE
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BAY OF FUNDY
ATLANTIC OCEAN
0
50 km.
DRUMLIN ORIENTATION INDICATING ICE·FLOW

Fig. 24. Orientation of Drumlins.
Cameron (1966)

Additional evidence of ice movement is provided by the grooves and scratch marks (striae) which were made by hard rocks as they were dragged across the surface of softer strata. Each phase of ice movement produces its own set of markings and occasionally striae pointing in different directions can be found on the same rock surface. Examples of glacial striae can be found on many exposed rock ledges but particularly good examples can be seen in Point Pleasant Park, Halifax, at the Ovens Natural Park on the west side of Lunenburg Harbour, and on the south side of Lake Kejimkujik.

WATER LAIN DEPOSITS

As the ice melted immense quantities of sands and gravel were released and sorted by the seasonal streams and rivers issuing from the front of the glacier or flowing across its surface. Eskers were formed by streams beneath or within the ice, kames formed in low areas on the ice surface, alluvial fans were built up where streams entered temporary lakes, and outwash plains developed in front of the glacier as the heavily burdened streams carried sand and gravel from the retreating ice front.

Eskers

Eskers are steep-sided ridges up to 100 feet (30 m) high, composed of poorly sorted sands, gravels and rounded cobble stones. They run across country for up to 6 miles (10 km), sometimes at an angle to the existing water courses, but more often along rivers or natural drainage channels. Those eskers which seem to be superimposed on the topography probably formed within the ice and later slumped down; the others which follow natural drainage channels formed at the base of the ice.

Eskers are rare in northern Nova Scotia but are common in the southwestern counties. One of the best known is the "Boar's Back" which runs for nearly 12 miles (20 km) from Halfway River along the west side of River Hebert in Cumberland County. The Sable, Jordan and Clyde Rivers (unit 412) in southwestern Nova Scotia each have eskers along some part of their courses. Eskers are also found inland particularly near the edges of lakes. The maps listed in the references should be consulted for localities.

Kames and Kame Terraces

Kames are mounds of stratified sand, gravel, and water worn cobble stones which were deposited in pools and holes within the ice and along its margin. If the material is dropped from melting water flowing along the surface of the ice at the side of a valley, a kame terrace may be formed.

Kames and kame terraces are very common throughout the province; the terraces are particularly conspicuous along valleys and in water gaps. In northern Nova Scotia good examples of kame deposits can be found in the Parrsboro Gap, the Folly Gap, Wentworth Valley, and along the divide between the Parrsboro River and River Hebert (unit 311). Kame terraces are also found along the Gaspereau River in Kings County and south of Berwick and Aylesford. In Cape Breton they occur along the Sydney River. Most valleys in southern Nova Scotia have examples of kame deposits and many can be seen from the highways.

Outwash Deposits

The material carried away from the front of the glacier by streams is sorted and deposited over a wide area as fans, deltas and plains. It has a variable texture (depending upon the ratio of sand to cobble stone), may be very variable in thickness within a fairly small area, and is generally well drained.

Outwash deposits are particularly thick where glacial meltwater was channelled through passes and down river valleys. Good examples are found south of the Parrsboro and Folly Gaps and at the mouths of all the rivers between Truro and Parrsboro. They were also formed in the Stewiacke River Valley and near the James River south of Antigonish. In Guysborough County the river valleys were almost filled with sand and gravel. Indian Harbour River has deposits along most of its length, and Indian Harbour Lake has been cut off by a wide alluvial bar. Country Harbour and Isaac's Harbour have extensive deposits on their margins, while at New Harbour the inlet is divided into sandy bars by outwash material. In Cape Breton outwash deposits can be seen in many valleys but are particularly well developed in the northern part of the Mira Valley and in most of the Margaree Valley.

Waterlain and Wind Sorted Sand

In the northwestern part of the province the Annapolis-Cornwallis valley (district 610) is covered with fine sands. Some were deposited by streams, some in glacial lakes and some were carried by the wind and deposited as dunes - the latter can be found in the area around Kingston. Loess, a fine wind-blown silt, is also found on the slopes of the South Mountain between Middleton and Nicholsville and in the vicinity of Debert. Farther west, deltas were formed near Bear River and at Sandy Cove on Digby Neck.

Water sorted glacial deposits provide potential reserves of sand and gravel and have been mapped as such by the N.S. Department of Mines and Energy, though not always with their morphological name attached.

ASSOCIATED TOPICS

T13 Glaciation, T28 Offshore Bottom Deposits

REFERENCES

Cameron (1966)
Fowler and Dickie (1977)
Grant (1971, 1977, 1980)
King (1969)
Prest et al (1968)
Roland (1982)
Stea and Fowler (1979, 1981, 1982)

COLONIZATION

T15 Post-glacial Climatic Change

In the 10,000 years since the most recent retreat of the continental ice sheet, Nova Scotia experienced a warming trend until temperatures were two or three °C above present temperatures, followed by a gradual cooling. This picture is pieced together from evidence from a variety of sources. Cores have been taken from a number of lakes and bogs, the sediment layers dated, and the pollen found within them analysed and counted. Fossils of marine molluscs and crustaceans, and disjunct distributions of present day fauna provide evidence of changing oceanic climates.

It is known that for the last billion years there have been ice ages at approximately 250 million year intervals. Also, for about nine tenths of this period, the climate has been more congenial than it is today. Exact causes for climatic change are not known, but the range of possibilities fall into three categories:

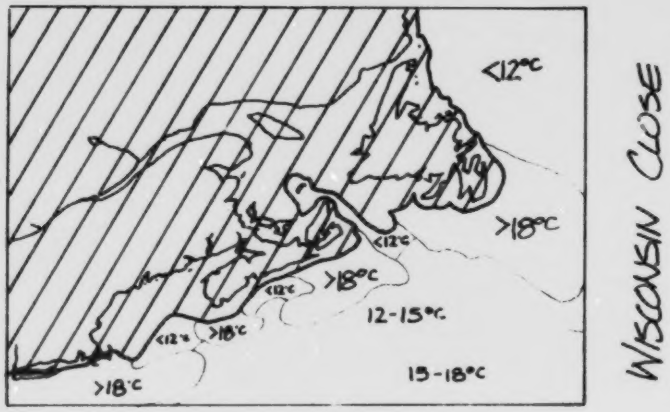
-astronomic and solar causes	eg. sun spot activity or changes in the earth's orbit
-geophysical causes	eg. continental drift
-atmospheric causes	eg. particulate matter from volcanoes affecting radiation.

The result of large scale climatic change is a shifting of the ranges occupied by the different air masses, with a consequent change in the boundaries of the major vegetation regions. As the ice sheet melted tundra vegetation colonized the bare ground. As temperatures gradually rose this was replaced first by birch, then spruce, and finally, in the warmest or hypsithermal period, by pine, hemlock and oak. A gradual cooling then saw the return of spruce, birch and beech.

Figure 25 illustrates an interpretation of the melting of the ice sheet, the changes in sea water temperatures and levels, and the relationship of climate and vegetation.

REFERENCES

Railton (1975)
Terasmae (1975)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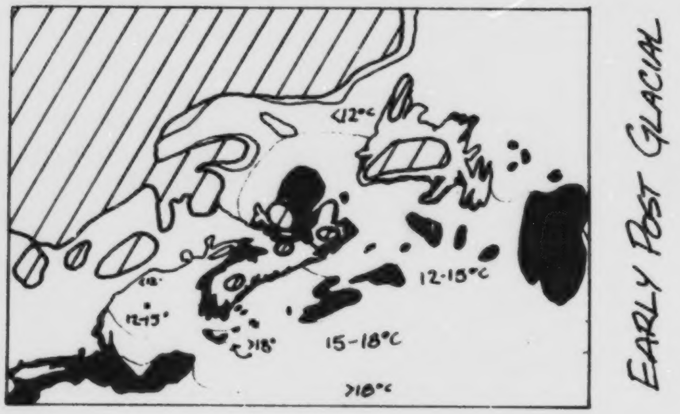
WISCONSIN CLOSE

15,000 years ago

- Ice Sheet beginning to retreat.
- 10-15°C below present, cold and dry.
- Sea levels 150 m below present levels.
- Tundra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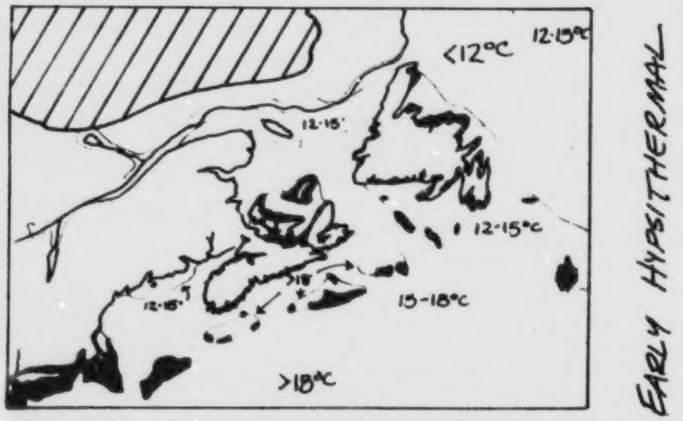
EARLY POST GLACIAL

12,500 years ago

- Ice pockets remain in S.W., on the North Shore and in the Bras d'Or Lake.
- 5-10°C below present
- Sea levels 100 m below present levels, cold Labrador current deflected eastward by raised Grand Banks.
- Water column stratified in summer.
- Tundra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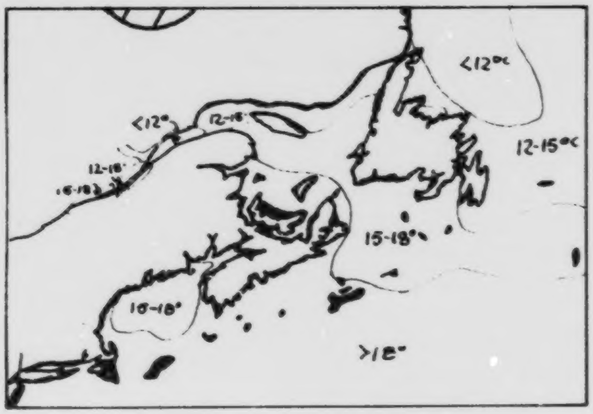
EARLY HYPSITHERMAL

9,500 years ago

- Ice gone from Nova Scotia.
- Temperatures similar to present.
- Sea levels 50 m below present levels.
- First closed boreal forests - spruce, fir, birch.

Fig. 25. Areas of Continental Shelf Exposed and Ocean Temperatures During Post-glacial Time.

Railton (1975)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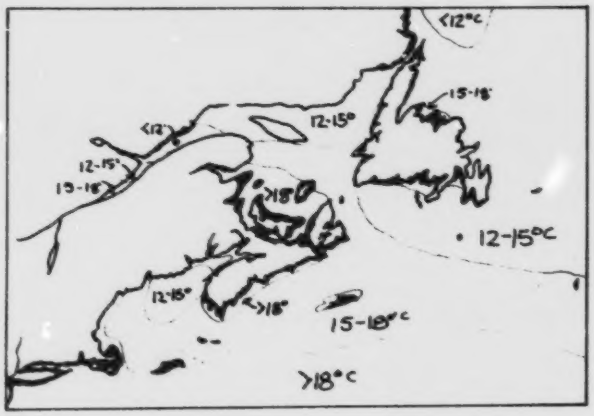
CLIMATIC OPTIMUM

7,000 years ago
- Continental ice virtually gone.
- At least 2.5°C above present.
- Sea levels 30 m below present levels, water warm in summer. Low tidal amplitudes.
- Pine, birch and oak.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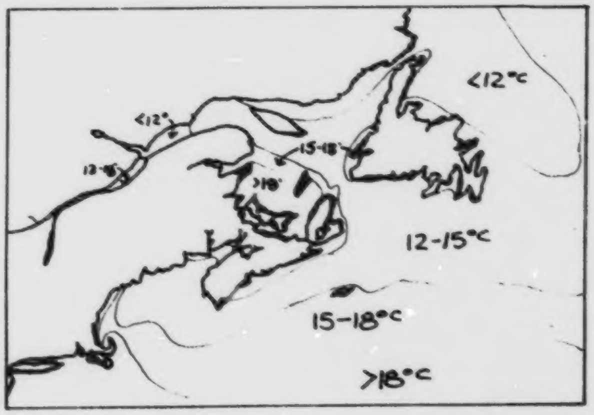
LATE HYPSITHERMAL

5,000 years ago
- Temperatures cooling
- Sea level 15 m below present.
  Stratification breaks up.
- Labrador Current flowing in over submerged Grand Banks.
- Hemlock and oak.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POST HYPSITHERMAL

3,000 years ago
- Temperature almost at present levels.
- Sea levels almost to present.
- Spruce, birch, beech.

Fig. 25. Areas of Continental Shelf Exposed and Ocean Temperatures During Post-glacial Time.

T16 Colonization by Plants

PREGLACIAL VEGETATION IN EASTERN CANADA

Roland and Smith (1969) suggest that "there is no reason to think that the vegetation (of Nova Scotia) just before the last glaciation was substantially different from that existing at the present time". The pre-glacial vegetation of the region had evolved in a number of major centres over millions of years. Plants of our tolerant deciduous forests, for example, show closer relationships with those of eastern Asia than they do with western Europe, indicating that a long period of separation had existed between the North American and European land masses. It is thought that until late in the Tertiary a mild climate led to the existence of a wide deciduous vegetation belt ranging from eastern United States and Canada to Alaska and down the eastern Asia coast. A number of our present herbaceous species, e.g. Mayflower, (Epigaea rupens), Clintonia (Clintonia borealis), Blue Cohosh (Caulophyllum thalictroides) and Northern Bedstraw (Galium kamschaticum) either exhibit disjunct distributions encompassing eastern North America, western North America and eastern Asia, or have closely related species which together exhibit such a disjunct distribution. During the recent period of glaciation in North America the species of our present deciduous forest remained in refugia south of the glacial margin.

The other major group of plants which existed in the region prior to glaciation were those typical of our present coniferous forests.

There is however no evidence to indicate that a wide band of coniferous forest, similar to our present boreal forest, existed prior to the Pleistocene. Some of the evergreen species existed in more northerly latitudes, some occurred along the windswept coast, and others existed in alpine areas and in refugia on mountain tops further south.

GLACIATION

It is safe to assume that repeated advances and retreats of glacial ice over the province during the Pleistocene completely eradicated all preglacial vegetation from the land mass which is now Nova Scotia. During interglacial periods the nature of the vegetation recolonizing the exposed land mass has been documented through pollen profile studies conducted on organic sediments in Cape Breton (Livingstone, 1968), but all such vegetation was eradicated by subsequent ice advances over the region.

POST GLACIAL FLORAL ELEMENT IMMIGRATION

The general trends in post glacial vegetation change in Nova Scotia have been documented through pollen profile studies conducted by Livingstone (1968), Ogden (1960) and Railton (1975). Generally, from about 10,000 years ago until about 7,300 years ago, tundra vegetation gave way to boreal vegetation, where fir, birch and spruce predominated. Pine and oak became more important in the forest vegetation of much of the province until about 6,000 years ago. Following the pine maxima, pollen of hemlock, beech and other deciduous species became more significant in the pollen profiles over much of the province.

Roland describes the flora of Nova Scotia in the following manner: "The plants of Nova Scotia may be divided into a number of groups called floral elements, with each floral element composed of those plants which have more or less the same distribution outside the area and therefore somewhat the same phytogeographic history. All of our floral elements may be considered extraneous as they have migrated into the area from outside the Province, although their earlier evolution undoubtedly occurred in a northern climate before glaciation occurred.

The main centres from which plants radiated into newly-exposed areas are those immediately outside of the glacial front, either from reservoirs of plants south of the terminal limits of the ice advance, from plants pushed southward by the advancing glaciers, or from the exposed areas on the outer limits of the coastal plain.

Roland identifies six floral elements;

Arctic-Alpine and Boreal Disjunct	The 61 plant species of these elements were the first to migrate into the area under the cool climatic conditions following glaciation. They have a scattered distribution, often only being known from one or two locations. This suggests that they are relic elements of a flora which was widespread immediately following glaciation, but which is now better represented further north. The presence of many of the plants at high elevations further south indicates that they moved northwards into Nova Scotia following the retreat of the ice. Some of them may have survived on the exposed coastal plain.

In the early stages of colonization soils would have been more alkaline before extensive leaching had taken place, competition would have been less on the newly exposed areas, and the climate would have been more severe. As these conditions changed the plants of these elements survived only in locations favourable to them - cool areas, headlands around the coast, the Cape Breton plateau, deep ravines, or shaded cliffs.

Some of the plants are found at sea-level around the coast (region 800). These include:

Sedum rosea	Rose-root
Claytonia fontana	
Lycopodium selago	Fir Club-moss
Betula michauxii	
Geum peckii	

Over twenty species are found in the Bay of Fundy-Cobequid area (district 310), including five unusual ferns. Examples of this group include:

Woodsia ilvensis	Rusty Woodsia
Woodsia glabella	Smooth Woodsia
Asplenium Trichomanes	Maidenhair Spleenwort
Asplenium viride	Green Spleenwort
Dryopteris fragrans	Fragrant Fern
Arabis hirsuta	(Rock-cress)
Arabis Drummondii	

These and additional species also occur in the highlands of northern Cape Breton, usually along moist, steep-walled river gorges (district 220). Three species are plants of the high barrens and bogs:

Betula glandulosa	(Birch)
Betula borealis	
Vaccinium uliginosum	Alpine Whortleberry

Other species, relatively rare and only found in northern Cape Breton (district 210), include:

Saxifraga aizoides	(Saxifrage)
Diapensia lapponica	
Pinguicula vulgaris	Butterwort

Another group of plants appears to be characteristic of boreal deciduous woods rather than coniferous woods. Part of this group may be called the Cordilleran element because the plants are common in similar cool moist habitats on the

Pacific Coast or in the Rocky Mountains. Examples of this group are the two ferns:

Dryopteris filix-mas	Male Fern
Polystichum braunii	

Boreal

The boreal forest is the most extensive forest type in Canada. The typical plants of the boreal element are found in coniferous woods, and in swamps, swales and bogs. Their distribution is more uniform than that of more southern plants, sometimes occuring around the northern hemisphere. Common examples include:

Typha latifolia	Broad-leaved Cat-tail
Habenaria hyperborea	Green Habenaria
Myrica gale	Sweet Gale
Alnus crispa	Downy Alder
Moneses uniflora	One-flowered Shinleaf
Chamaedaphine calyculata	Leather Leaf
Linnaea borealis	Twinflower

Plants of this element with a more northern or Hudsonian range are found chiefly on headlands and barren areas in cooler parts of the province (regions 100, 200 and 800). Examples include the junipers and the Bakeapple.

Canadian

The plants of this element are widely distributed and can be said to form the background flora of northeastern North America. They range from Nova Scotia and Newfoundland to Manitoba, south to Pennsylvania, and in the mountains in North Carolina and Tennessee. They are commonly found in open woods, pastures, barrens or old fields. The element includes a range of shrubs such as Wire Birch, Choke-cherry, Mountain Maple, Witherod and Hardhack; and also a number of ericaceous or heath plants such as Rhodora, Lambkill, and various blueberries. Other common examples include:

Onoclea sensibilis	Sensitive Fern
Pontederia cordata	Pickerel-weed
Maianthemum canadense	Wild Lily-of-the-valley
Clintonia borealis	Clintonia
Habenaria psychodes	Purple Fringed Orchid
Epigaea repens	Trailing Arbutus (Mayflower)
Gaultheria procumbens	Teaberry

Alleghanian

The plants of the Alleghanian element are mainly associated with the deciduous forests far to the south. The range is from Nova Scotia to Minnesota and south to the Gulf States. In Nova Scotia they are usually found growing in rich soils in the best deciduous woods or along river intervales in the northern part of the province from Annapolis County to Cape Breton (regions 500 and 600). Some of the species are widespread, but many are rare. These plants presumably migrated along the Chignecto Isthmus (unit 523) when this area was at a higher elevation above sea level than it is now. Examples include:

Athyrium thelpyterioides	Silvery Spleenwort
Allium tricoccum	Wild Leek
Erythronium americanum	Dog's Tooth Violet
Trillium erectum	Purple Trillium
Ostrya virginiana	Hop-hornbeam
Sanguinaria canadensis	Bloodroot

Southwestern

The southwestern part of the province, south of a line from Digby Neck to Musquodoboit Harbour, has a distinctive flora. The plants typical of this region are usually absent from other quartzite and granitic regions. A characteristic feature is the mingling of northern and southern plants.

The plants of the southwestern flora are believed to have survived during the last glaciation in a refugium off the Atlantic Coast, or to have moved northward over the exposed coastal plain while the glacier was retreating. The exposed land, with its ponds, sandy or peaty soils, and stream edges, presented a suitable area for colonization by more southern plants. As the sea-level rose these plants gradually became isolated from their range further south, and they are not found today in New Brunswick, Maine or Massachusetts.

The following are examples from the group of plants now found from Florida to Louisiana or Texas (some even to Mexico or the West Indies) and north along the coast to New England, before jumping to southwestern Nova Scotia. These plants are sometimes called the Coastal-plain Element:

Woodwardia areolata	Dwarf Chain Fern
Panicum dichotomiflorum	Panic Grass
Habenaria flava	Fringed Orchid
Hydrocotyle umbellata	Water-pennywort

Other plants which are distinctly coastal plain in nature and are very common in southwestern Nova Scotia, have developed a wider distribution and also occur inland, in Cape Breton, and often in southern Newfoundland. These include:

Juncus militaris	Rush
Calopogon pulchellus	Calapogon
Drosera intermedia	Narrow-leaved Sundew
Viola lanceolata	Lance-leaved Violet
Gaylussacia dumosa	Bog Huckleberry

A few plants have left the coastal plain almost entirely, but still have close relatives on the coastal plain or farther south. An interesting example is *Schizaea pusilla*, Curly Grass Fern. This species is isolated from related species in the tropics and the southern hemisphere, and is now found elsewhere only in the New Jersey pine barrens. In Nova Scotia it is common in the southwest and along the coast to the Cape Breton plateau.

Plants of the Seashore

About fifty species are restricted to beaches, cliffs and salt marshes along the seashore. A few of these plants have a more southern origin and range, analagous to the coastal-plain flora. Examples include:

Spartina patens	
Limonium nashii	Sea-lavender
Solidago sempervirens	Seaside Goldenrod

Many of the most common seaside plants have a northerly distribution similar to plants of the Boreal floral element. This group includes:

Hierochloe odorata	Sweet-grass
Juncus balticus	
Juncus gerardii	
Lathyrus japonicus	Beach Pea
Mertensia maritima	Sea-lungwort
Plantago maritima	Seashore Plantain

A smaller number of species are found only in eastern North America and in Europe. Their range is somewhat less northern, extending southward from the warmer areas around the Gulf of St. Lawrence:

Ammophila breviligulata	American Beach-grass
Cakile edentula	Sea-rocket
Ligusticum scothicum	Scotch Lovage

REFERENCES

Livingstone (1968)
Ogden (1960)
Railton (1975)
Roland and Smith (1969)

T17 Colonization by Animals

As with the flora, the pre-glacial fauna of Nova Scotia is believed to have been essentially similar to that of the present day. The successive glaciations completely obliterated animals from the area now above sea level, but it is believed that refugia existed, south of the terminal moraines of the ice sheet, along the edge of the continental shelf. The post-glacial hypsithermal period, about 5,000 BP., allowed the development of a temperate fauna in Nova Scotia. This included "southern" species such as Blanding's Turtle, the freshwater snail Menetus dilatatus, and marine clam Mercenaria mercenaria. The routes by which these animals were able to colonize Nova Scotia are shown in Figures 26 and 27.

LAND AND FRESHWATER FAUNA

The Chignecto Isthmus land Bridge (unit 533)	This has existed continuously since the end of the last glaciation, and as the climate warmed species were able to migrate freely from the continent. Freshwater species could move from one river system to another due to the freshwater on the coast that was coming from the melting ice sheet. It has been shown that there is decreasing species diversity of freshwater fish with greater distance into Nova Scotia from the land-bridge. A similar pattern for freshwater mussels has also been reported. The recent occurrence of coyote in Nova Scotia demonstrates that this migration route is still active.
Coastal Plain Refugia	Refugia were believed to have existed along the continental shelf and were occupied by plants and animals during the ice age. As the ice melted and the climate warmed these species were able to migrate northwards, displacing arctic species. As the sea level rose and the climate cooled, this element of the fauna has been largely restricted to the Atlantic coast, especially in southwestern Nova Scotia.

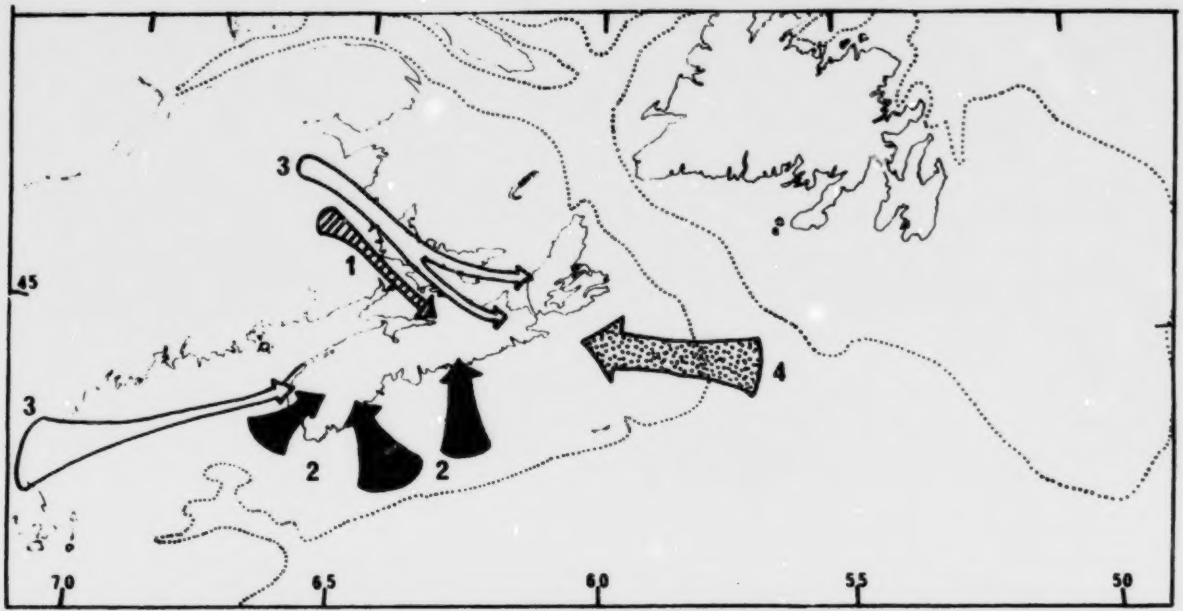
3
1
3
2
2
4
45
70
65
60
55
50

Fig. 26. Post-glacial colonization of Nova Scotia by land and freshwater animals. 1. Chignecto land bridge, 2. Continental shelf refugia, 3. Aerial migration and transportation, 4. Direct and indirect importation by Europeans (post 1,000 AD).

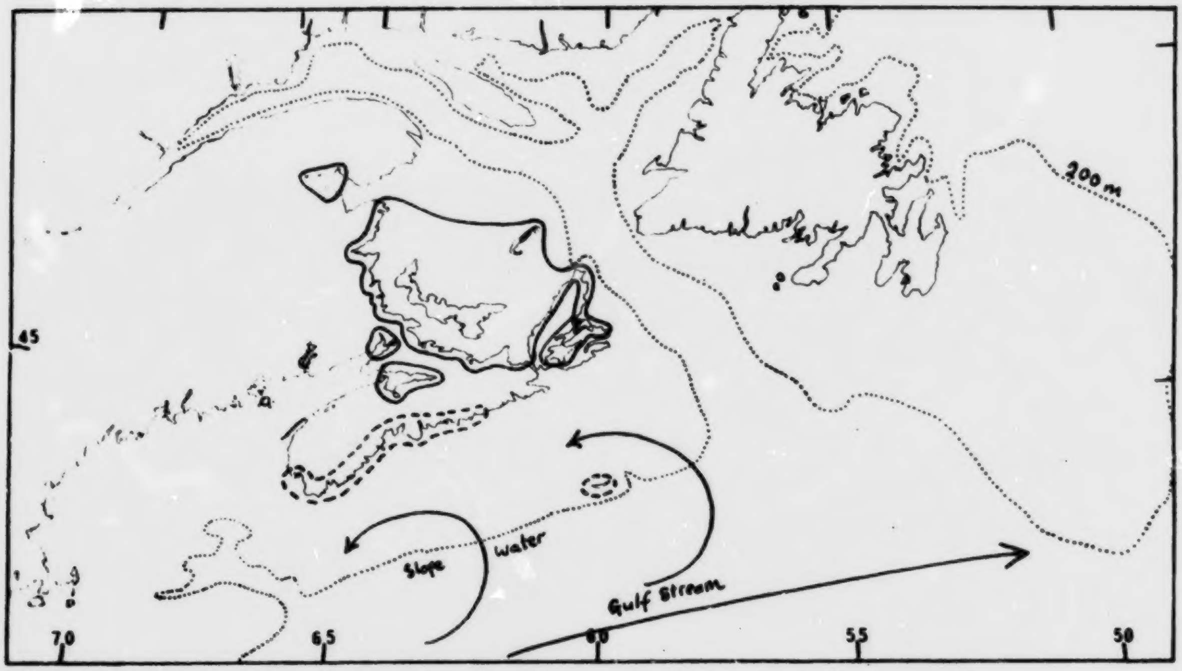
200 m
45
Slope water
Gulf Stream
70
65
60
55
50

Fig. 27. Post-glacial colonization of Nova Scotia coasts by marine organisms.

◯ Main areas for warm water species established during the hypsithermal.

◌ Areas for warm water species established during the hypsithermal, and currently, in part, maintained or enriched through slope-water exchange.

Aerial Migration and Transportation Those animals which can fly experience few physical barriers and thus were able to colonize Nova Scotia as soon as climate and habitats were suitable. Birds, bats and insects are the groups able to follow this route, and present distribution patterns (with modification due to climate and habitat change) have probably been established for a long time. Flying animals are known to transport sessile species and are important agents in their distribution.

Introductions The contemporary fauna also includes an introduced component of growing significance. The direct or indirect importation of species by Europeans may go back as far as 1,000 years. This fauna originated from other parts of North America, Europe, South America and Asia. Initial introductions came with cultivated plants and ships ballast, and many species experienced rapid spreading with land clearance and agriculture. This type of introduction has caused widespread displacement of native species and introduced species may be commonly found in native habitats.

MARINE FAUNA

The marine fauna was originally arctic/boreal in nature, associated with the predominately cool water temperatures of the area. However, species with more southerly affinities have colonized the area in the past. During the period following the last glaciation, warm water, 65°F (18°C), more characteristic of areas south of Cape Cod, extended northwards in coastal areas into the Bay of Fundy, the continental shelf and the southern Gulf of St. Lawrence. (Bousfield and Thomas, 1975). This enabled warm water species ("oyster bed fauna") to colonize these areas. However, as the climate subsequently cooled, areas occupied by the warm water fauna became isolated. The fauna of Minas Basin and the southern Gulf of St. Lawrence were separated, and are now different in character. Species along the Atlantic Coast are isolated in sheltered bays, where temperatures rise sufficiently in the summer time to permit reproduction. The warm water fauna around Sable Island is now largely extinct.

The Southern Atlantic coast of Nova Scotia (South Shore and parts of the Eastern Shore) are periodically subjected to incursions of warm water from the continental shelf. This water is partly derived from the Gulf Stream and includes the larvae of marine animals which normally occur further south. During the summer time the larvae arriving in this way may undergo metamorphosis and become noticeable as part of the fauna of bays and estuaries. Because of low temperatures in winter these animals rarely survive or reproduce. However, there is the possibility that populations could be established following some climatic improvement or local warming of water through industrial activity.

REFERENCES

Athearn and Clarke (1961)
Bousfield and Thomas (1975)
Livingstone (1951)
Mackie (1979)
Roland and Smith (1969)

CLIMATE, CURRENTS AND TIDES

T18 The Dynamics of Nova Scotia's Climate

Basic Factors

The main features of Nova Scotia's climate are ample and reliable precipitation; a fairly wide but not extreme temperature range; a late and short summer; skies that are often cloudy or overcast; frequent coastal fog; and marked changeability of weather from day to day. These features can be related to four basic factors:

a) the prevailing westerly winds.
b) the interactions between the three main air masses which converge on the eastern coast.
c) Nova Scotia's position astride the routes of most major eastward moving storms.
d) The modifying influence of the sea.

Wind Systems

The basic eastward movement of the wind systems (known as the westerlies) over North America is a result of the general circulation of warm air from the Equator towards the pole being deflected to the right by the Coriolis effect - a force apparently set up by the rotation of the earth. The westerlies, though subject to much local disturbance, bring Nova Scotia a continental type of climate, albeit much modified. As a result of air moving across a large land mass, which heats up and cools down more quickly than a body of water, a continental climate shows greater variations of temperature, both daily and seasonally, than a maritime climate. Nova Scotia therefore experiences warmer summers, colder winters and a higher snowfall than might otherwise be expected of an area of land which is almost an island. The sea nevertheless plays a strong modifying role.

Major Air Masses

Much of the variability of the weather is caused by the shifting positions of the three main air masses which dominate the eastern seaboard (See Figure 28). Continental arctic air from the north west is very cold and dry in the winter. Maritime polar air, moving in from the north or northeast, has been somewhat warmed by its passage over the ocean and is cool and moist. Maritime tropical air from the south and southwest is warm and moist. The boundary where two air masses meet is called a front. The clouds and precipitation which often accompany the passing of a front are caused by the lifting of the warmer air mass over the edge of the colder air mass, causing the warm air to cool, and the water vapour it may be carrying to cool and condense.

Two major atmospheric pressure systems influence the circulation of air (See Figure 29). The Bermuda and Azores High, an area of very constant high pressure east of Bermuda, feeds hot humid air into the southern United States where it may be picked up or entrained by the prevailing westerlies, particularly in summer. In the fall and winter this route tends to be blocked by a temporary high pressure system over the southern part of the continent, and the tropical airstream will instead move intermittently up the east coast, bringing a series of storms to the Atlantic provinces.

The Icelandic Low is situated near Iceland and South Greenland in winter, but tends to weaken and move westwards towards the Hudson Strait in summer. Most of the cyclones which sweep across North America eventually die out in the area of the Icelandic Low.

Storm Tracks

A prominent feature of Nova Scotia's weather is the fairly frequent movement of low pressure systems, or cyclones, over the area. Three streams of cyclones converge:

a) one which moves into British Columbia and the Yukon from the Pacific and moves right across the country, often reinforced by moist air from the Mississippi Valley.

b) one which develops in the midwestern states of the U.S., moving in across the Great Lakes.

c) one which forms in hot humid air over the tropical Atlantic, the Caribbean, or the Gulf of Mexico, and then sweeps round, first westwards in the United States and

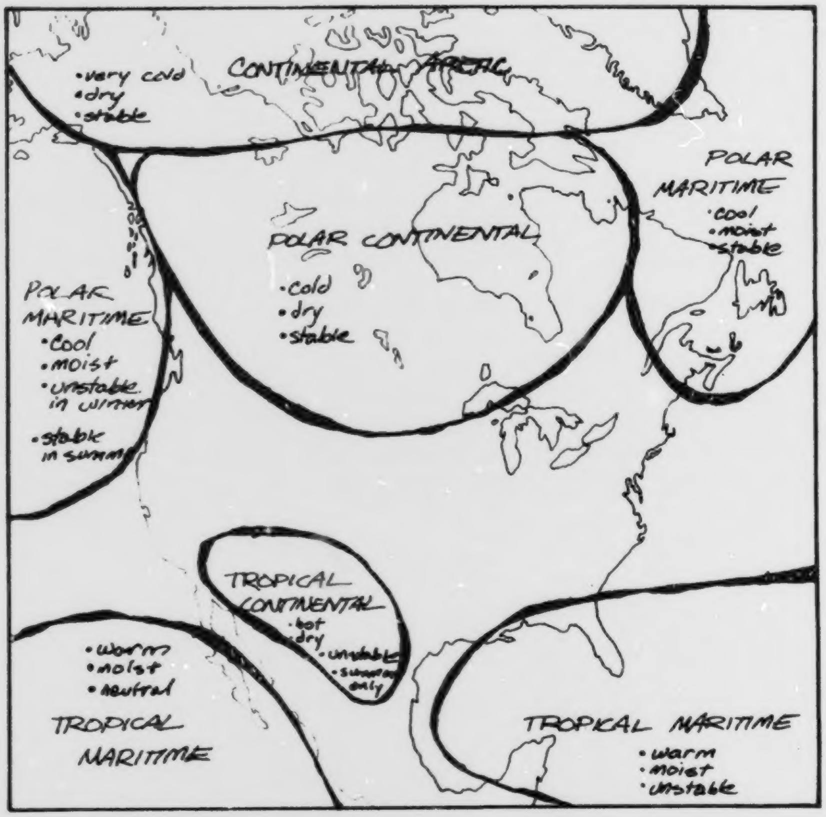
•very cold
•dry
•stable
CONTINENTAL ARCTIC
POLAR MARITIME
•cool
•moist
•stable
POLAR CONTINENTAL
•cold
•dry
•stable
POLAR MARITIME
•cool
•moist
•unstable in winter
•stable in summer
TROPICAL CONTINENTAL
•hot
•dry
•unstable
•summer only
•warm
•moist
•neutral
TROPICAL MARITIME
TROPICAL MARITIME
•warm
•moist
•unstable

Fig. 28. Major air masses occurring over North America.

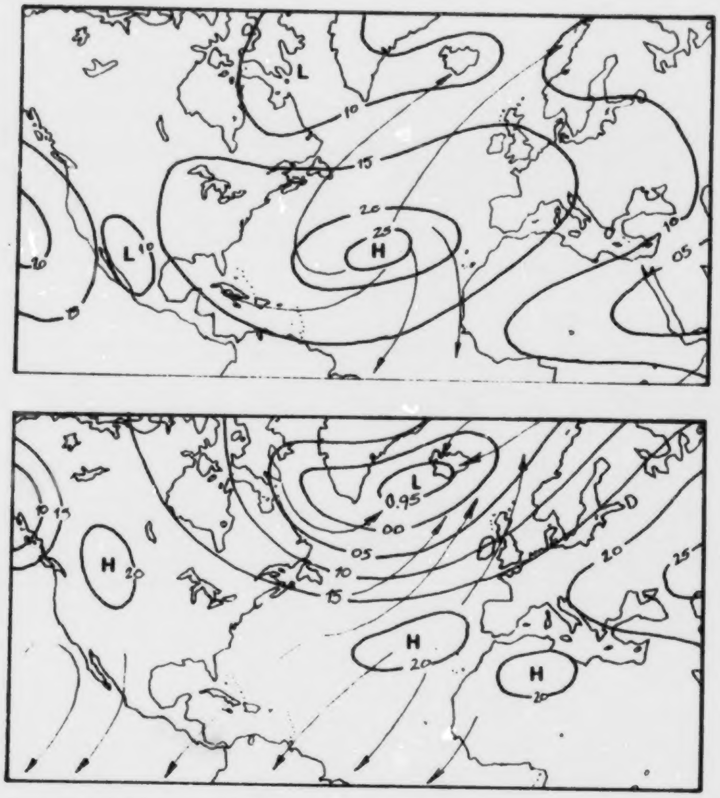
L
10
15
20
25
H
L
10
05
H
20
L
0.95
00
05
10
15
H
20
H
20
H
20
20
25

Fig. 29. Atmospheric Pressure Systems; Summertime, Bermuda High (above) and Wintertime, Icelandic Low (below). Units shown are millibars above 1,000 millibars. Hare and Thomas (1974)

then joining the westerlies to move up the east coast of the continent, bringing some of the most significant storms to the Atlantic provinces.

Coastal Influence

The weather that moves into the Atlantic region is modified in a number of ways by the seas that surround the province. Owing to the thermal properties of water the sea is much slower than the land to warm up or cool down. Cold winds from coastal waters therefore delay the arrival of spring. Similarly fall is extended and the onset of winter held off. Along the coast a local convection cell may form. During the day air over the land may warm and rise resulting in cool breezes moving in off the sea. At night this movement is reversed as the land cools the air above it more quickly than the sea.

Pack ice which forms in the Gulf of St. Lawrence and on the west coasts of Cape Breton is a further cooling influence in spring, particularly in the northern part of the province. The cold Labrador current and the warm Gulf stream have significant effects on temperatures in different parts of the province, causing respectively a generally colder climate along the Eastern shore, and a much milder climate in southwest Nova Scotia.

REFERENCES

See T20 Nova Scotia's Climate

T19 The Seasons

Winter	In winter air mass dominance is shared by cold Continental arctic air and the moister Maritime polar air, with the prevailing winds being west or north-west. But the weather is rarely settled because a series of low pressure cells are moving up from the south, bringing storms as the colder air is briefly replaced by the warmer Maritime tropical air. Sometimes the path of a storm will take a more northerly route over the centre of New Brunswick and warm southwest winds will bring thaws to Nova Scotia and southeastern Newfoundland. Cloud cover is persistent and wind speeds are high.
Spring	Spring comes slowly to Nova Scotia, especially in coastal areas. The passage of midwest or Atlantic coast storms over the region often sweeps in cold Arctic air alongside the warmer Maritime air. As the warmer air moves northward over the cold waters of the Labrador current dense fogs are formed.
Summer	Usually sometime in June the frequent outflows of Arctic air abate as the southern border of the Arctic and Polar air masses migrates northwards. A rather brief summer begins, dominated by Maritime tropical air. The heat and humidity experienced by Ontario and Quebec are, however, modified by the coastal influence. Cyclones moving out of the midwest are usually not severe, but in late summer the province is often traversed by the remnants of tropical hurricanes, which increase the incidence of rain in August.
Fall	Fall is the season of the greatest cyclonic activity in the tropical western Atlantic, bringing heavy rains. In between storms, however, there is often clear settled weather, and the coastal influence helps to prolong the season.

T20 Nova Scotia's Climate

Climate Regions

Nova Scotia has a modified continental climate with proximity to the coast and elevation determining local variations in climate. The coastal influence is the major one in Nova Scotia since the relief of the province is not extreme and only the Cobequid Mountains and the Cape Breton Highlands have elevations over 1,150 feet (350 m). Dzikowski (1984) divides Nova Scotia into 9 broad climatic regions (See Figure 30), which provide an overview of the variety of climatic conditions found in the province.

a) Northumberland Shore (district 530)-
has a delayed spring, a warm summer and fall, but a cold winter, and the lowest precipitation in the province, being sheltered from storm winds from the south and east. The Northumberland Strait is a shallow, sheltered body of water that warms quickly in summer and freezes in winter, and provides less of a moderating effect than other coastal waters.

b) Northern Nova Scotia (region 300 and much of 500)-
the highlands receive high snowfall and have the coldest winter temperatures, but quite warm summer temperatures.

c) Cape Breton Highlands (regions 100 and 200)-
receive the highest total precipitation in the province and have cool temperatures summer and winter.

d) Eastern Nova Scotia (parts of regions 400 and 500)-
a diverse geographic area with high rainfall, and generally cool temperatures due to the influence of the cool Labrador current.

e) Western Nova Scotia (most of region 400)-
a gradual slope upwards from the Atlantic Coast, with high rainfall and warmer temperatures than Eastern Nova Scotia.

f) Annapolis Valley (region 600)-
a sheltered lowland with the warmest temperatures and the lowest precipitation total on the mainland.

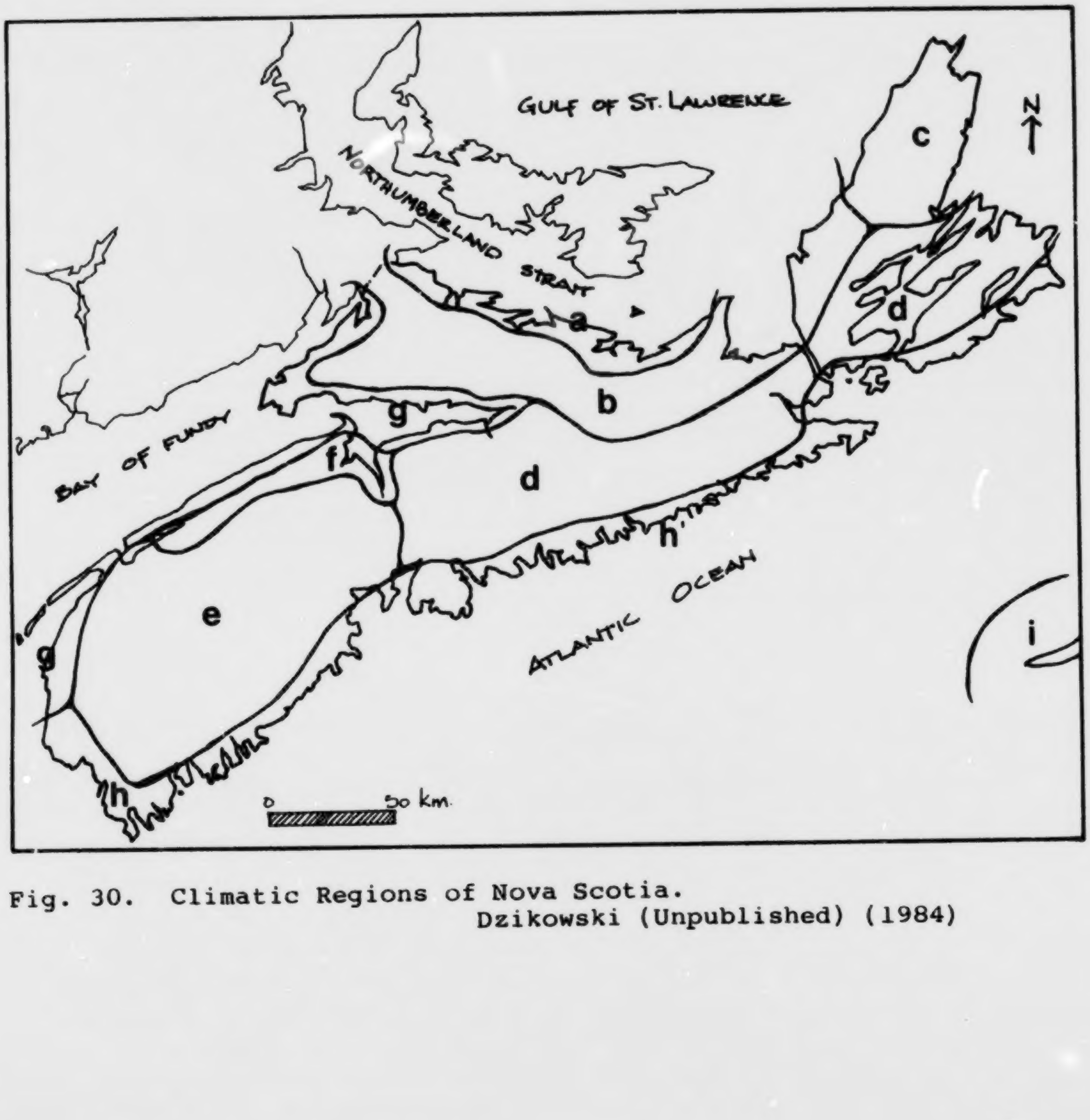
GULF OF ST. LAWRENCE
NORTHUMBERLAND STRAIT
N
c
d
a
b
g
BAY OF FUNDY
f
d
h
e
ATLANTIC OCEAN
i
g
h
0
50 km.

Fig. 30. Climatic Regions of Nova Scotia.
Dzikowski (Unpublished) (1984)

g) Bay of Fundy Region (region 700)-
a narrow strip along the coast from New Brunswick to Yarmouth. A strong coastal influence produces a long cool summer and a mild winter. There is frequent fog and moderate precipitation.

h) Atlantic Coastal Region (region 800)-
a strong coastal influence produces the coolest summer and warmest winter temperatures in the province. However, this effect extends only several kilometres inland. The moderating influence is strongest in the extreme south west where the coastal waters are well mixed and unstratified. Rainfall amounts are high and there is frequent, heavy sea fog.

i) Sable Island (region 900)-
has a marine climate characterized by a narrow temperature range, little snowfall and frequent fog. It is unsheltered and exposed to high winds.

These regions do not, however, take into account extensive local variations, particularly along the coast.

Temperature

The mean annual temperature lies between 40 and 45°F (5 and 7°C) for most of Nova Scotia, except in the Cobequids and Cape Breton Highlands, where it is less. The annual range of temperature is greatest in the vicinity of the Northumberland Strait with over 45°F (25°C) difference between the mean temperatures of the warmest and coldest months, decreasing to a range of 20°F (10°C) along the southwest coast (See Figure 31).

January and February are the coldest months, and July and August are the warmest. In January the coldest mean temperatures, below 20°F (-7°C), are found in the Cobequid Hills (region 300) and the Cape Breton Highlands (regions 100 and 200), while the warmest, above 40°F (5°C), are found along the southern and western coasts. In July the situation is reversed, with the southern coastal belt being cooler than the inland areas. The shallow waters of the Northumberland Strait and the upper reaches of the Bay of Fundy exert a local warming influence, while the Gulf Stream moves further offshore in the summer months.

Mean daily temperatures fall below freezing between late November and mid December across most of the province. The period of freezing temperatures ends in mid March in southwestern Nova Scotia, but extends into April in the higher areas in the northern part of the province. The winter period therefore ranges from 80 days at the southwestern tip to over 120 days in the Cobequids and is longest on Cape Breton Highlands (region 100).

Winds

Winds are strongest in the colder months and most frequently from the west or northwest, as the cold Arctic air moves in. In the summer winds from the southeast or south predominate.

Precipitation

The mean total annual precipitation (rainfall plus the snowfall converted to its equivalent in water - approximately one-tenth) ranges from less than 50 inches (1,250mm) along the Northumberland Strait and in the central low lands to over 65 inches (1,600mm) in the wettest area on the Cape Breton Highlands plateau (See Figure 32). The seasonal distribution of precipitation is fairly even, with the cold half of the year receiving approximately one third more than the warm half. Measurements of precipitation at four stations in the province indicated that measurable precipitation occurred on the average 152 to 179 days in the year, while significant precipitation, 0.1 inch (2.5mm or more) occurred on about 60-65 percent of those days. A dry month is usually considered to be one in which no more than 1 inch (25mm) of rain falls. Dry months are not common anywhere, but are somewhat more likely to occur in the Annapolis Valley, eastern Cape Breton and the North Shore.

Snowfall

The lowest snowfall is to be found in coastal areas where onshore winds blow in warmer maritime air, causing the precipitation to fall as rain. The greatest total snowfalls are found on the Cobequids and the Cape Breton Plateau. Snowfall tends to vary from year to year more than the total annual precipitation (See Figure 33). In some areas the variation from the mean values exceeds 40 percent. The median winter maximum snow depth ranges from less than 12 inches (30cm) in coastal areas to

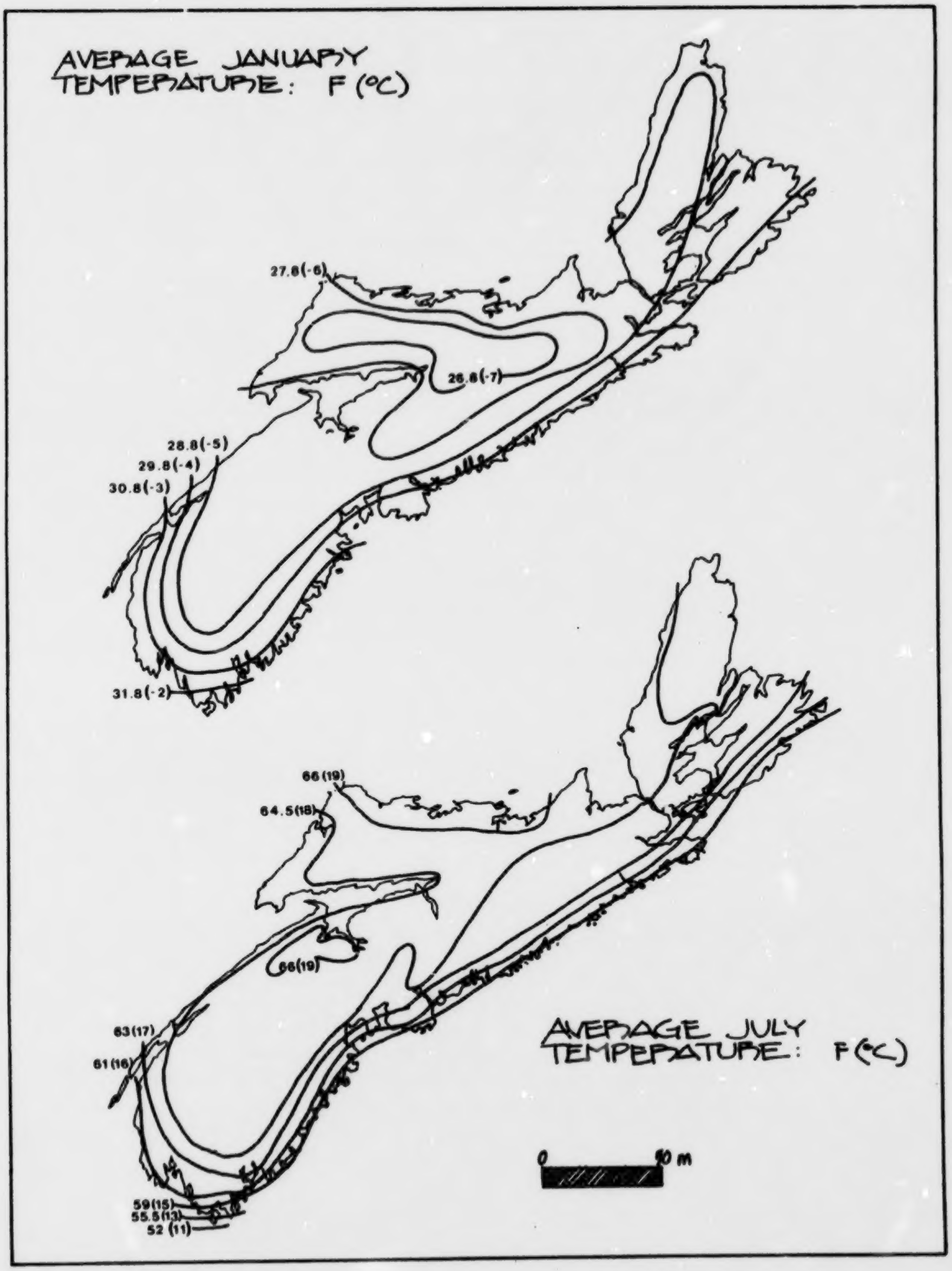
AVERAGE JANUARY TEMPERATURE: F (°C)
27.8(-6)
26.8(-7)
28.8(-5)
29.8(-4)
30.8(-3)
31.8(-2)
66(19)
64.5(18)
66(19)
63(17)
61(16)
59(15)
55.5(13)
52 (11)
AVERAGE JULY TEMPERATURE: F(°C)
0
50 m

Fig. 31. Average Temperatures for January and July in Nova Scotia. Dzikowski (1980)

more than 30 inches (75cm) in upland and highland areas but at least once in twenty years it can be expected that the maximum snow cover over much of the province will be in the range of only 8 inches (20cm) or a little more. Nor is snow on the ground throughout the season as thaws often occur. Away from the Atlantic shoreline during the snow cover season, snow cover is likely 75 percent of the time, especially over high ground. Near the Atlantic and the mouth of the Bay of Fundy snow cover can only be expected 50-65 percent of the time.

Fog

The Fundy and Atlantic coasts are frequently affected by sea or advection fogs, formed as warm, moist air moves over a cooler surface. On average these coasts will experience fog for 15-25 percent of the year. The peak month for sea fog is usually July. Sea fog tends to move inland at night as the land surface cools rapidly, and then retreat to the coast by day. The southwestern tip and Sable Island are most influenced by fog. In Yarmouth fog is recorded on average one out of every three days. The Northumberland Strait shore is relatively fog-free in the spring because of the predominance of cold winds off the ice in the Gulf, and in summer because of the warm temperatures of the shallow waters in the Strait.

In other parts of the province radiation fog caused by rapid night-time cooling of the land under a clear sky, plays a more important role, with average annual frequencies of only 10-15 percent. This type of fog occurs most often in November.

Humidity

Relative humidity tends to be high because of the local influence of the surrounding sea, and because of the frequent incursions of air of Maritime tropical origins. In the summer even Continental arctic air will be moist because of the vast numbers of lakes crossed in its path. The mean annual relative humidity tends to be highest along the Atlantic Coast.

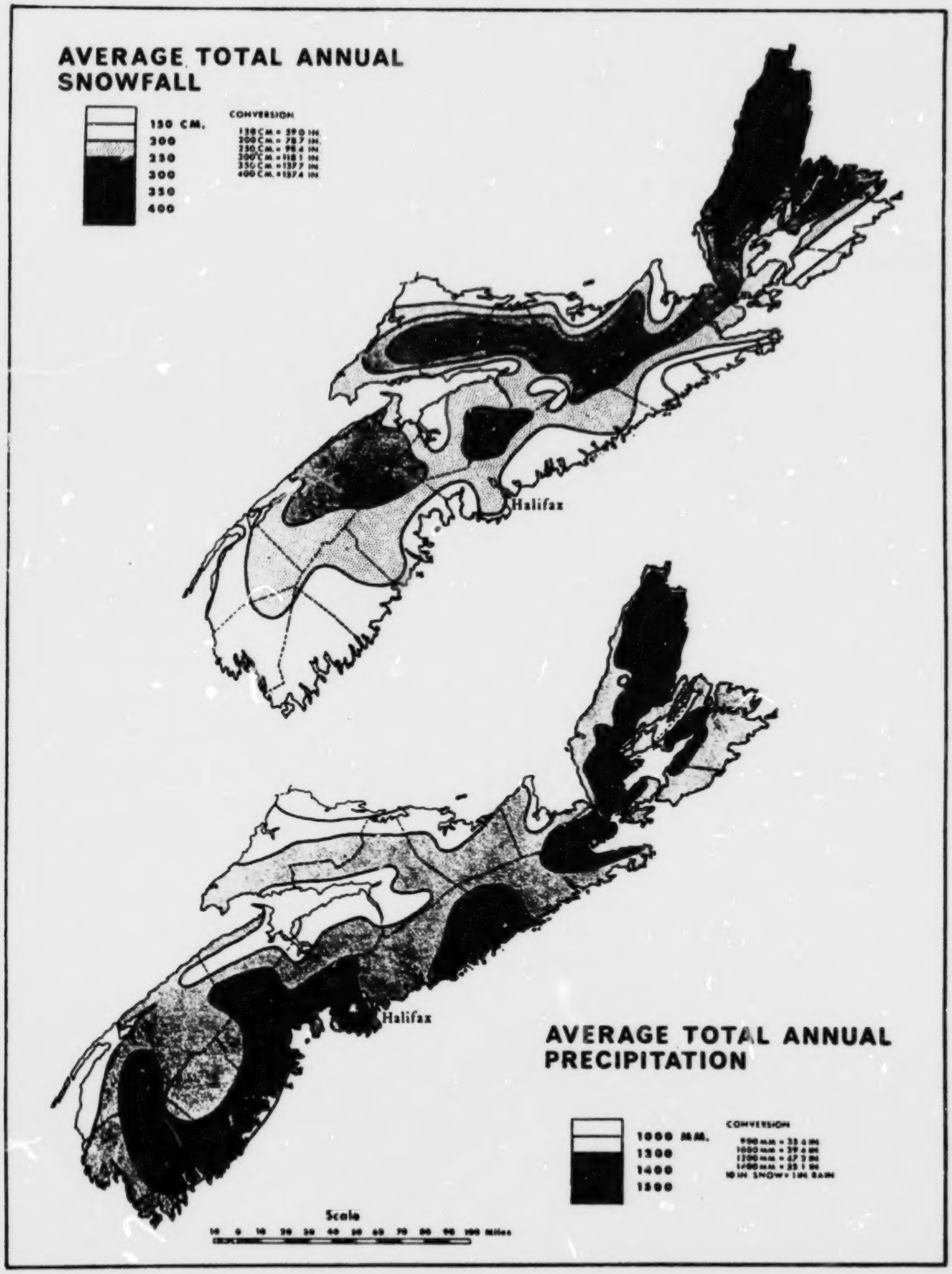
AVERAGE TOTAL ANNUAL SNOWFALL
150 CM.
200
250
300
350
400
CONVERSION
150 CM. = 59.0 IN.
200 CM. = 78.7 IN.
250 CM. = 98.4 IN.
300 CM. = 118.1 IN.
350 CM. = 137.7 IN.
400 CM. = 157.4 IN.
Halifax
Halifax
AVERAGE TOTAL ANNUAL PRECIPITATION
1000 MM.
1200
1400
1500
CONVERSION
900 MM = 35.4 IN
1000 MM = 39.4 IN
1200 MM = 47.2 IN
1400 MM = 55.1 IN
10 IN SNOW = 1 IN RAIN
Scale
10 0 10 20 30 40 50 60 70 80 90 100 Miles

Fig. 32. Snowfall, and Fig. 33. Precipitation in Nova Scotia. Gates (1975)

Sunshine and Cloudiness Because of intensive frontal activity, local coastal effects and the frequency of fog formation, Nova Scotia does not receive as much bright sunshine as areas further inland. The annual mean number of bright sunshine hours range from 1,747 at Nappan to 1,946 at Shearwater. Sable Island has a mean of only 1,459 hours. These may be compared with the annual means for Ottawa (1,995 hours) and Toronto (2,045 hours).

Climatic Normals Climatic normals are available from the Atmospheric Environment Services. Information is published on temperature, precipitation, wind, solar radiation, degree days, frost and bright sunshine. Data are based on a thirty year period, and are updated every ten years.

ASSOCIATED TOPICS

T31 Soil Development and Soil Climate

REFERENCES

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Brookes (1972)
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T21 Ocean Currents

OCEAN CURRENT DYNAMICS

The surface waters of the oceans are principally moved by the frictional force of the winds. For this reason the general oceanic circulation corresponds to an extent with the atmospheric circulation. In the northern hemisphere, because of the Coriolis effect, the water is transported in a direction somewhat to the right of the direction of the wind. As the Atlantic Ocean is largely hemmed in by continental land masses, large scale gyres are set up. In the mid-latitudes of the northern hemisphere the gyre moves clockwise, powered one way by the westerlies which blow across North America, and the other way by the North East Trade winds (Figure 34).

In the more northerly latitudes the subpolar gyre sweeps round counter-clockwise, powered by the easterlies which move round the top of the persistant Icelandic low pressure area, and then back by the westerlies. Because of the earth's rotation to the east the water tends to pile up on the western edges of the oceans, with the result that Western Boundary currents are noticeably deeper, narrower and faster than their Eastern Boundary counterparts.

There are also deep currents in the ocean, which move more slowly than surface currents. Because different areas of the oceans receive different quantities of radiant energy from the sun, the waters at the equator expand more, creating a very slight slope along the surface of the oceans to the poles. The warm surface waters move "downhill" towards the poles. As they cool and evaporation takes place, they increase in density and salinity and sink, displacing deeper water and setting up a deep current. The deep current circulation system is not yet completely understood, but there is substantial evidence that a definite deep current of cold water, with high oxygen and salinity levels, is formed in the Labrador Sea and flows southward off the coast of North America (Figure 35).

Circulation in the Northwest Atlantic

The movements of waters off Nova Scotia are dominated by two major currents, the Labrador Current and the Gulf Stream, which form the western edges of the subpolar and mid-latitude

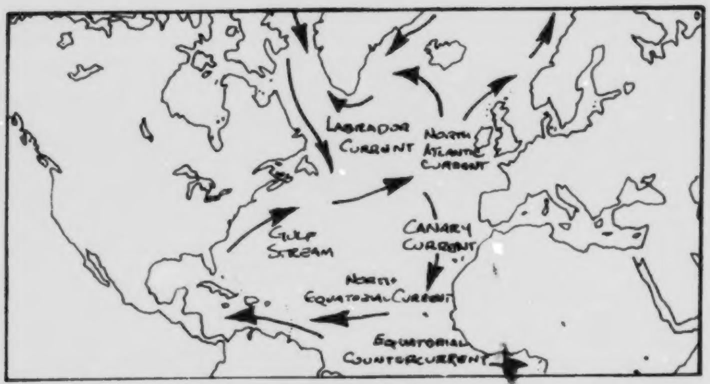
Labrador Current
North Atlantic Current
Gulf Stream
Canary Current
North Equatorial Current
Equatorial Countercurrent

Fig. 34. North Atlantic Ocean Surface Currents

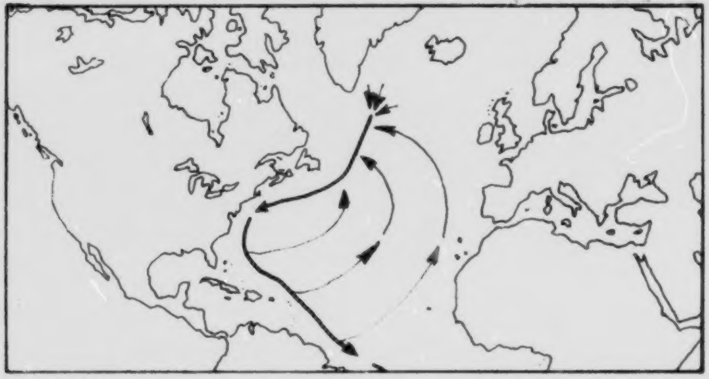

Fig 35. Generalized Deep Ocean Currents.
Ingmanson and Wallace (1973)

oceanic gyres shown on Figure 36. The mixing of these two currents, together with the influence of outflows from the Gulf of St. Lawrence, creates a complex and variable pattern of water bodies, each with differing characteristics of temperature and salinity.

Labrador Current

The Labrador Current is formed by the confluence of the West Greenland and Baffin Island Currents, supplemented by flows out through the Hudson Strait. Off the coast of Newfoundland the Labrador Current branches. The inshore branch, mostly consisting of cold, low salinity water of polar origin, moves over the continental shelf. Sometimes it also moves into the Gulf of St. Lawrence through the Strait of Belle Isle and the Cabot Strait. The offshore branch, consisting of relatively more temperate waters derived from the West Greenland Current, moves out along the continental slope.

The Gulf Stream

The Gulf Stream System is composed of the Florida Current, the Gulf Stream and the North Atlantic Current. It derives its energy from the merging of the North and South Equatorial Currents, which piles up water in the Gulf of Mexico. The Gulf Stream moves northward as a relatively narrow band of warm, highly saline water. Off most of the coast of the United States the Gulf Stream is very strong and clearly defined, but as it moves northwards it develops many branches or filaments. It is possible for eddies, as much as 80 miles (130 km) in diameter, to separate entirely from the main current, carrying bodies of tropical water closer inshore.

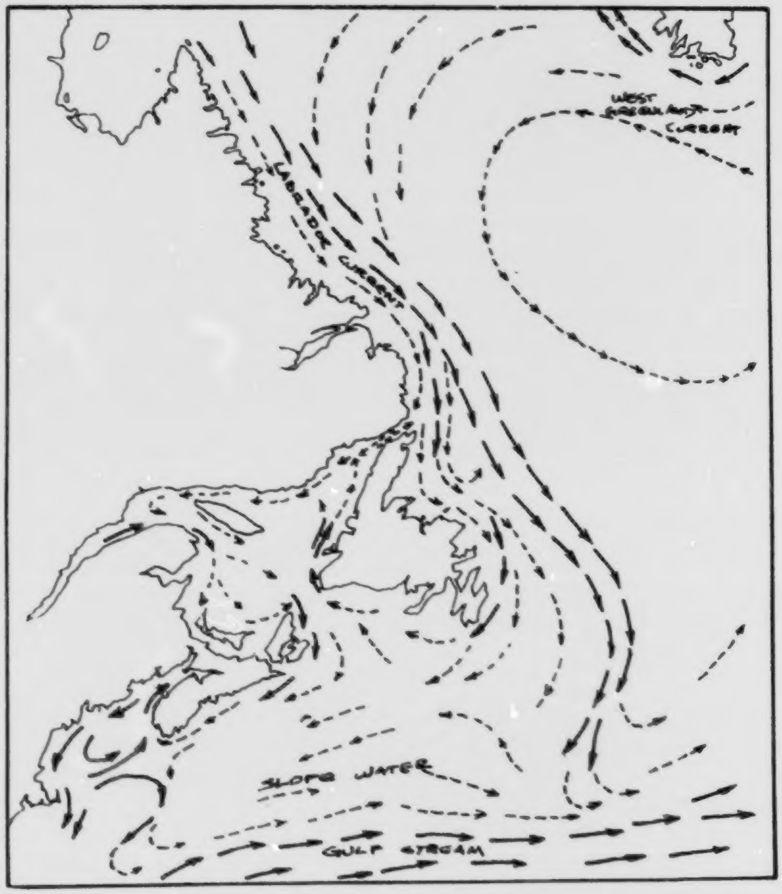

Fig. 36. Northwest Atlantic Ocean Surface Circulation Patterns. Leim and Scott (1966)

The Gulf Stream can change its course dramatically. Off Halifax its northern edge may be within 250 miles (400 km) of the coast, or as far away as 500 miles (800 km). The more northerly positions occur in early winter and late summer. This has been explained by reference to the seasonal variations in the strength of the wind systems, caused in turn by the changes in location and intensity of the Bermuda High - the idea being that the northward drift of the Gulf Stream is caused by a weakening of the driving forces. However, more recent reinterpretations have questioned the nature of the relationship between the wind systems and the position of the Gulf Stream because of the immense amounts of potential energy stored in the warm core of the central North Atlantic. In theory this energy could, in the absence of winds, sustain a considerable current for several days.

Circulation in the Gulf of St. Lawrence

The surface circulation in the Gulf of St. Lawrence is essentially anticlockwise, driven by the St. Lawrence River outflow, resulting in an eastward flow of water along the shallow channel in the Northumberland Strait. The outward flow of surface waters through the Cabot Strait forms the Cape Breton Current (also called the Cabot Stream). It is balanced by a deeper inflow of cooler, more saline water. While the volume of water transported by the Cape Breton Current is small compared to the Labrador Current or the Gulf Stream, it maintains its separate identity over the Scotian Shelf because of its lower density.

Circulation of the Scotian Shelf and in Bay of Fundy

The general circulation on the Scotian Shelf is anti-clockwise, with a predominantly southwesterly drift along the coast called the Nova Scotian Current, and a northeasterly drift along the edge of the continental shelf. The Nova Scotia Current is a mixture of water from the Gulf of St. Lawrence and the more saline slope water.

In the Bay of Fundy the general circulation is also anti-clockwise, with the inward moving water at higher levels on the Nova Scotia side. This is largely a result of non-linearities in the tidal motion. Such a mechanism is important here because the tidal amplitudes and currents are extremely high.

When strong winds from the southwest predominate, a form of closed circulation results in the outflowing surface waters swinging round to re-enter the Bay. For this reason flushing times in the Bay are very variable. An average of 75 days has been estimated, but a range of times from 46 to 200 days has also been calculated. Water exchange has been shown to be at a minimum in January and at a maximum in May. The type of circulation, whether 'open' or 'closed', has considerable impact on the movements of free floating animals.

SPECIAL FEATURES

Ice

Usually only the North Shore along the Northumberland Strait, the west coast of Cape Breton, and the upper reaches of the Bay of Fundy are significantly affected by ice. Other shores may experience temporary freezing, and pack ice has, at times, drifted as far west as the southwestern tip of Nova Scotia (Figure 37).

In the Northumberland Strait strong currents and tides usually prevent the formation of a continuous sheet of ice, but harbours are usually closed from December or early January. Cape Breton harbours, where temperatures are slightly modified by the influence of Atlantic waters, usually stay open until January or February.

Pack ice in the Gulf of St. Lawrence mostly forms _in situ_. Another source is the St. Lawrence estuary, which freezes early - sometimes by mid-December. Pack ice, and occasionally small icebergs and growlers from arctic regions, will also enter the Gulf through the Strait of Belle Isle. The amount of ice depends partly on whether the dominant surface flow in the Strait is inward or outward, and partly on the amount of pressure exerted by the main body of pack ice in the Labrador Current. This northern ice is generally kept to the Quebec, Labrador and Newfoundland shores by the prevailing northwesterly winds.

Pack ice begins to move out of the Cabot Strait in January, but the real break-up season begins in March and April.

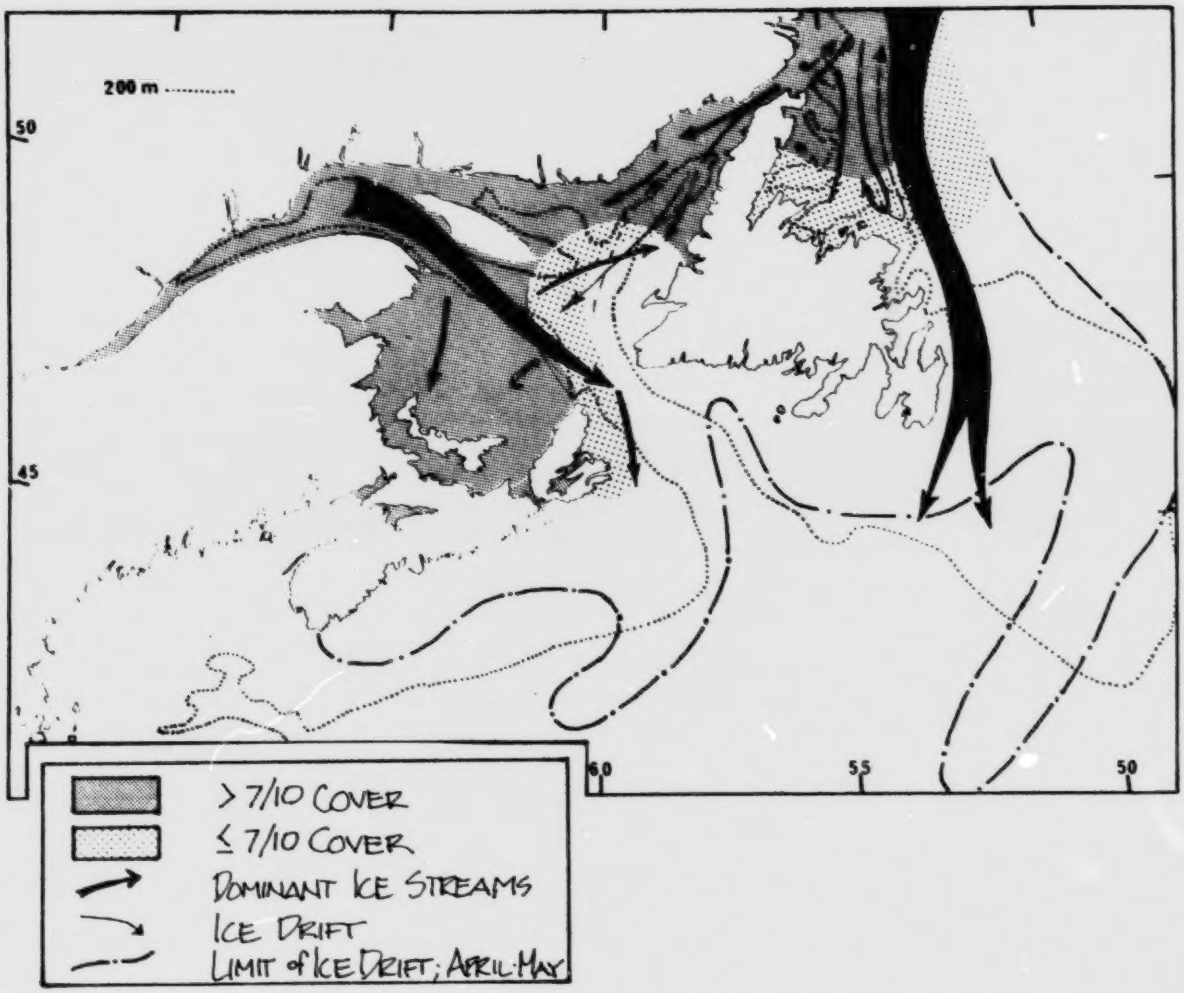
200 m
50
45
60
55
50
> 7/10 COVER
≤ 7/10 COVER
DOMINANT ICE STREAMS
ICE DRIFT
LIMIT of ICE DRIFT; APRIL-MAY

Fig. 37. Average Maximum Extension of Ice Conditions, Atlantic Provinces.
Owens (1977) and Brookes (1972)

Upwelling

The phenomenon of upwelling occurs when there is a divergence of surface waters because of wind or current conditions. The surface water is replaced by cold, deep, nutrient-rich water which can support higher productivity than the surrounding sea. The most famous example of upwelling occurs off the west coast of Peru, supporting highly developed fishing and guano industries. There is evidence that upwelling occurs off the southwestern tip of Nova Scotia, where large concentrations of surface-feeding seabirds occur, and off the Louisbourg shore of Cape Breton (distsrict 870).

Influence of the St. Lawrence

It has been suggested that the Gulf of St. Lawrence to the Gulf of Maine should be considered as one oceanographic system. Variations in temperature and salinity recorded in the Gulf of St. Lawrence, caused by fluctuations in the river discharge, can be correlated with changing conditions on the Scotian Shelf and in the Gulf of Maine, with an appropriate time lag to take account of coastal current drift speeds of 5-6 miles (8-10 km) a day.

ASSOCIATED TOPICS

T22 Tides, T23 Ocean Environments, T24-28 The Coastline

ASSOCIATED HABITATS

H1-2 Offshore Habitats

REFERENCES

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Drinkwater *et al* (1979)
Garrett and Loucks (1976)
Hachey (1961)
Ingmanson and Wallace (1973)
Petrie (1980, 1982)
Sutcliffe *et al* (1976)

T22 Tides

TIDAL DYNAMICS

Tides are the periodic rising and falling of the earth's oceans in response to the gravitational attraction exerted on the earth by the moon and the sun. The sun is over 390 times further away from the earth than is the moon. For this reason, in spite of its massive bulk, it exerts less than half of the force of the moon. The lunar element thus dominates the tidal cycle. In practice, the sun's influence is often even less. For example, along the Atlantic seaboard of North America the sun exerts only one fifth of the moon's influence.

Lunar Tides The gravitational pull of the moon produces a bulge in the waters on the side of the earth nearest to it. This gravitational attraction is countered by the centrifugal force generated by the revolving earth-moon system, so that a bulge of equal size is created on the opposite side. Because the earth is also rotating on its own axis, if no continents existed any given point on the earth's surface would pass through a bulge of water twice a day. In practice, of course, the movement of these bulges are impeded by land masses, but most parts of the oceans do in fact experience semi-diurnal tides.

Solar Tides The lunar tides occur twice in a lunar day, that is - once every 12 hours and 25 minutes. Solar tides are produced in a similar way, but are much smaller than lunar tides and occur twice every solar day, or once every 12 hours. This small difference in the period of the two types of tide has an important effect. Instead of a given point in the ocean experiencing a total of four high tides and four low tides every day, the effect of the solar tides is to augment or diminish the dominant lunar tides according to the relative positions of the sun and moon.

Spring and Neap Tides When the sun, moon and earth are in a straight line, with either the moon (new moon) or the earth (full moon) in the middle, the solar and lunar tides coincide, resulting in the higher spring tides. When the moon, earth and sun are at right angles the influence of the solar tide-producing forces will tend to augment the lunar low tide and diminish the lunar high tide. These more moderate tides are the neap tides. The range of spring tides may be greater than that of the neap tides by as much as 50 percent or more, and they occur as a two-week cycle (See Figure 38). As the sun's influence along the Atlantic coast is small, and even smaller in the Bay of Fundy, the differences between spring and neap tides are less than might otherwise be expected.

Perigee/ Apogee

Tide-producing forces are greatest when the moon is at the nearest point of its elliptical orbit and is said to be at perigee. When it is farthest away it is said to be at apogee. The moon goes from perigee to perigee in 27.5 days. The variation in the tide-producing forces can range from 85 percent of the mean value at apogee to 126 percent at perigee. When this latter situation coincides with a spring tide, a very large tide can be generated. Conversely, two weeks later the following set of neap tides will be weakened when the moon is at apogee.

Diurnal Tides

The orbits of both the earth and the moon are at an angle to the plane of the earth's equator. For this reason the sun appears high in the sky in the summer and low in the sky in winter. Similarly the moon moves from a northerly position to a southerly position and back again once every lunar month. This change in declination can cause a considerable difference between the ranges of the two semi-diurnal tides. In essence a point on the earth's surface is now moving through a thicker part of one bulge and a thinner part of the other. The dominant semi-diurnal tide is known as the diurnal tide. In certain places and at certain times of the year the diurnal tide may be so strong that only one high and one low tide will occur each day.

Amphidromic Circulation

As a result of the Coriolis effect (a tendency, resulting from the earth's rotation, for all particles in motion to be deflected towards the right in the northern hemisphere) the tides

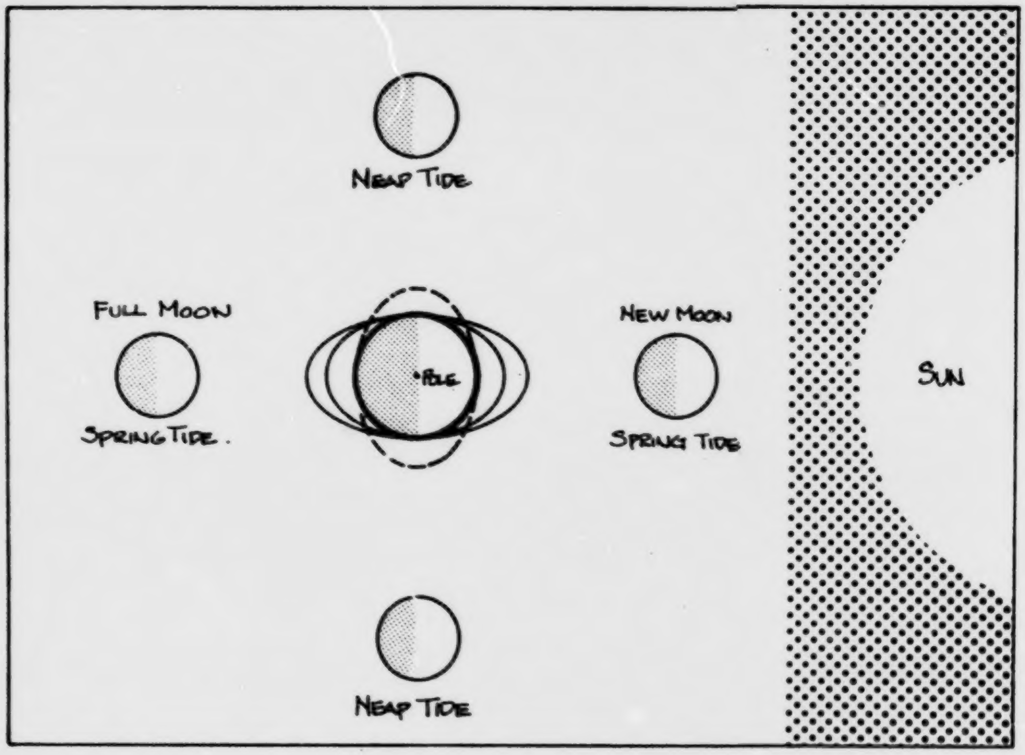


Fig. 38. Positions of Sun and Moon at Spring and Neap Tides
Ingmanson and Wallace (1973)

sweep in an anti-clockwise direction, radiating out from a centre called the amphidromic point. Tidal range increases with distance from this point. The tides along the Atlantic coast and the Bay of Fundy are part of the same system circulating around an amphidromic point in the middle of the North Atlantic (See Figure 39). Tides in the Gulf of St. Lawrence move out and around from a separate point located near the Magdalen Islands, but are modified by the general tidal movement in the North Atlantic.

Bays and Basins

Land obstructions prevent tidal currents moving freely around the earth. Instead the water moves backwards and forwards in semi-enclosed basins. This movement develops its own momentum, apart from the tidal forces. Every bay or basin has a natural period of oscillation depending on its length, depth and shoreline. If this period coincides with the period of the tides the two will augment each other, resulting in regular tides with high amplitude. When the two periods conflict substantially tides will tend to be low or irregular. The Bay of Fundy is tuned to tidal frequencies that have been generated in the Atlantic Ocean, resulting in ever increasing amplitudes towards the upper reaches. The same happens in the eastern and central parts of the Northumberland Strait which magnify the tides of the Gulf of St. Lawrence. In the western section, however, tides enter from both sides, negating each other's effect.

TIDAL PATTERNS IN NOVA SCOTIA

Atlantic Coast

High tide occurs at practically the same time all along the Atlantic coast. During the summer the highest tides occur during the evening and night hours. The average range of the tide is between 2.5 and 3.0 feet (0.8 and 1.0 m) along the edge of the continental shelf, increasing to 4.0 to 4.5 feet (1.2 to 1.4 m) along the Atlantic coast. At times the range can be up to 1.4 times as large.

Gulf of St. Lawrence

The Gulf of St. Lawrence is in effect an inland sea, with its own amphidromic circulation. The tides vary from place to place in the Gulf. They are generated by the tidal movements in the North Atlantic, with high tide in the Cabot Strait occurring approximately one hour after high tide on the Atlantic coast. In the southern section of the Gulf the diurnal tide is dominant for much of the year. Tides are fairly regular at the new or full moon, but at the quarters great inequalities may exist between two successive high or low tides. Tidal ranges in the Northumberland Strait are usually only 4.0 feet (1.2 m) or less. The low tidal amplitudes reduce vertical mixing and promote stratification.

In the summer water temperatures in the Northumberland Strait are higher than those on the Atlantic coast, 65-70°F (18-21°C as opposed to 50-60°F (10-15°C). The dominant features responsible are a) the large shallow areas, both in Northumberland Strait and over the Magadalen Shallows, b) the very low vertical mixing due to tides, c) the relatively

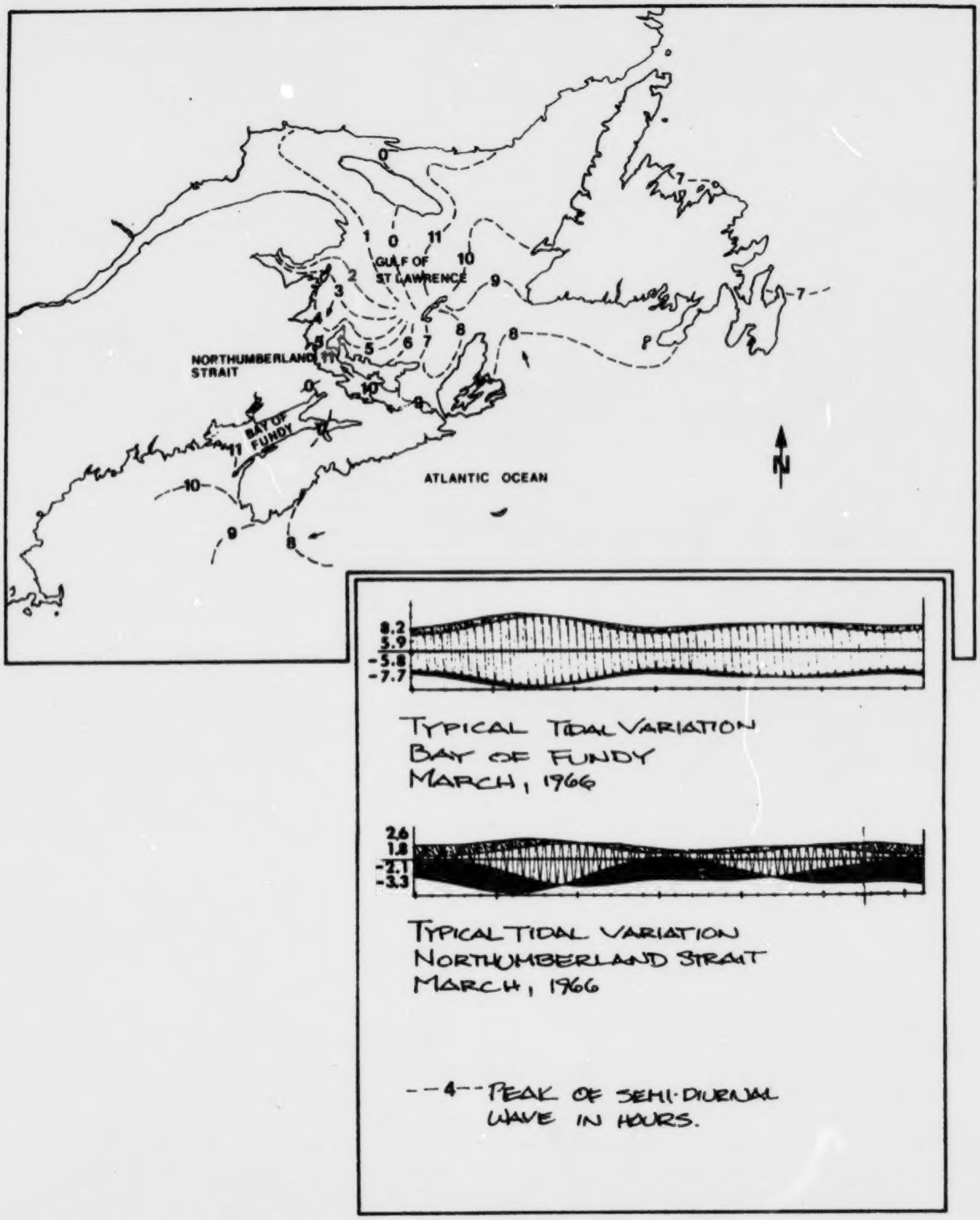

GULF OF ST LAWRENCE
NORTHUMBERLAND STRAIT
BAY OF FUNDY
ATLANTIC OCEAN
N
0
1
2
3
4
5
6
7
8
9
10
11
8.2
5.9
-5.8
-7.7
TYPICAL TIDAL VARIATION
BAY OF FUNDY
MARCH, 1966
2.6
1.8
-2.1
-3.3
TYPICAL TIDAL VARIATION
NORTHUMBERLAND STRAIT
MARCH, 1966
--4-- PEAK OF SEMI-DIURNAL WAVE IN HOURS.

Fig. 39. Tidal Conditions in Nova Scotia.
Desplanque (1973)

weak residual current, and d) the fact that, in summer, lower low water occurs during the day, leaving a greater area of the shallow sloping bottom to absorb the sun's radiant energy. These warm temperatures are reflected in the crustacean and molluscan fauna to be found along the margins of the Strait, which are similar to those found south of Cape Cod. In the winter, conditions are reversed. Water temperatures cool rapidly and ice forms readily.

Bay of Fundy

The Bay of Fundy is 250 miles (400 km) long (Bar Harbour to Truro) and has an average depth of 250 feet (75 m). Its natural period of oscillation is almost identical to that of the semi-diurnal tides in the Atlantic Ocean and the Gulf of Maine. The water moves backwards and forwards like a pendulum, needing only a small push from the Atlantic tide to keep it going. During every tide approximately 3.5 million million cubic feet (105 km^3) of water enter the Bay, increasing to 5.0 million million cubic feet (150 km^3) during large tides.

High water in the greater part of the Bay occurs 3.5 to 4 hours after high water along the Atlantic coast, and an hour later in the Minas Basin. Due to the Coriolis effect the incoming tidal current hugs the Nova Scotia shore, travelling at about 2.5 knots off Digby Gut. In the centre of the Bay the current moves at about 2 knots, slowing to 1.5 knots off Saint John, N.B. When the tide falls the opposite effect occurs as the out-flowing current moves to the New Brunswick coast.

As the tides spill over into the Minas Basin speeds of 7 to 8 knots are reached. The highest tides in the world are reported to be off Burntcoat Head in the upper part of Minas Basin, with a mean tidal range of 40 feet (11.9 m), but sometimes exceeding 53 feet (16 m).

Bras D'Or Lake

The two channels - the Great and Little Bras d'Or Channels - leading into the Bras d'Or Lake system are very narrow, allowing only a small volume of water to enter and leave with each tide. For this reason the tidal range is small, approximately 3 inches (0.08 m) nea Baddeck as opposed to 3 feet (0.9) m in the Cabot Strait. In smaller basins such as

Whycocomagh Bay the tidal range is almost non-existent. Tidal currents in the two channels can nevertheless be strong, with great variations in strength and direction at different depths. Barometric pressures can cause water levels in the confined lake to rise or fall by up to 1 foot (0.3 m) while the adjacent ocean is, of course, unaffected. The ocean water brought in through this process maintains the relatively high salt content in the system. Therefore, although they occur less frequently, the barometric tides have much greater impact on the Bras d'Or Lake than do the lunar tides.

Special Features

Tidal bores form when a large body of rapidly moving water enters a constricted estuary where the bottom has a long, shallow slope. The velocity of the inflowing water slows as the estuary becomes shallower, so that the water entering the channel moves faster than the water further in. The shallower water at the leading edge is slowed by frictional drag and overtaken by the deeper water behind, forming a standing wave called a tidal bore. In the upper reaches of the Bay of Fundy tides with a range of 40 feet (12 m) are common and in the zone from 10 feet (3 m) below to 10 feet (3 m) above Mean Sea Level the water rises at the rate of 3 feet (1 m) in 20 minutes. Estuaries with these characteristics occur in the Bay of Fundy, and tidal bores occur in the Maccan, Hebert, Salmon and Shubenacadie Rivers and also in rivers draining into the Avon River estuary. These bores can reach heights of 2 feet (0.6 m) moving at a speed of 5.5 miles/hour (8.7 km/hour) on the highest tides (See Figure 40).

IMPLICATION OF TIDAL VARIATIONS

Tidal variations around the coast of Nova Scotia, both spatially and daily or from season to season, affect the coastal environments in a number of ways. One of the most obvious, and clearly evident in the Bay of Fundy, is that a large tidal amplitude results in extensive areas of inter-tidal habitat. When this amplitude is coupled with significant tidal or other surface height variations, for example, storm surges, a wide range of saltmarsh and mudflat habitats develop - some of them inundated regularly, others only intermittently. The varying conditions place high stresses on living organisms, few species being adapted to survive such harsh conditions.

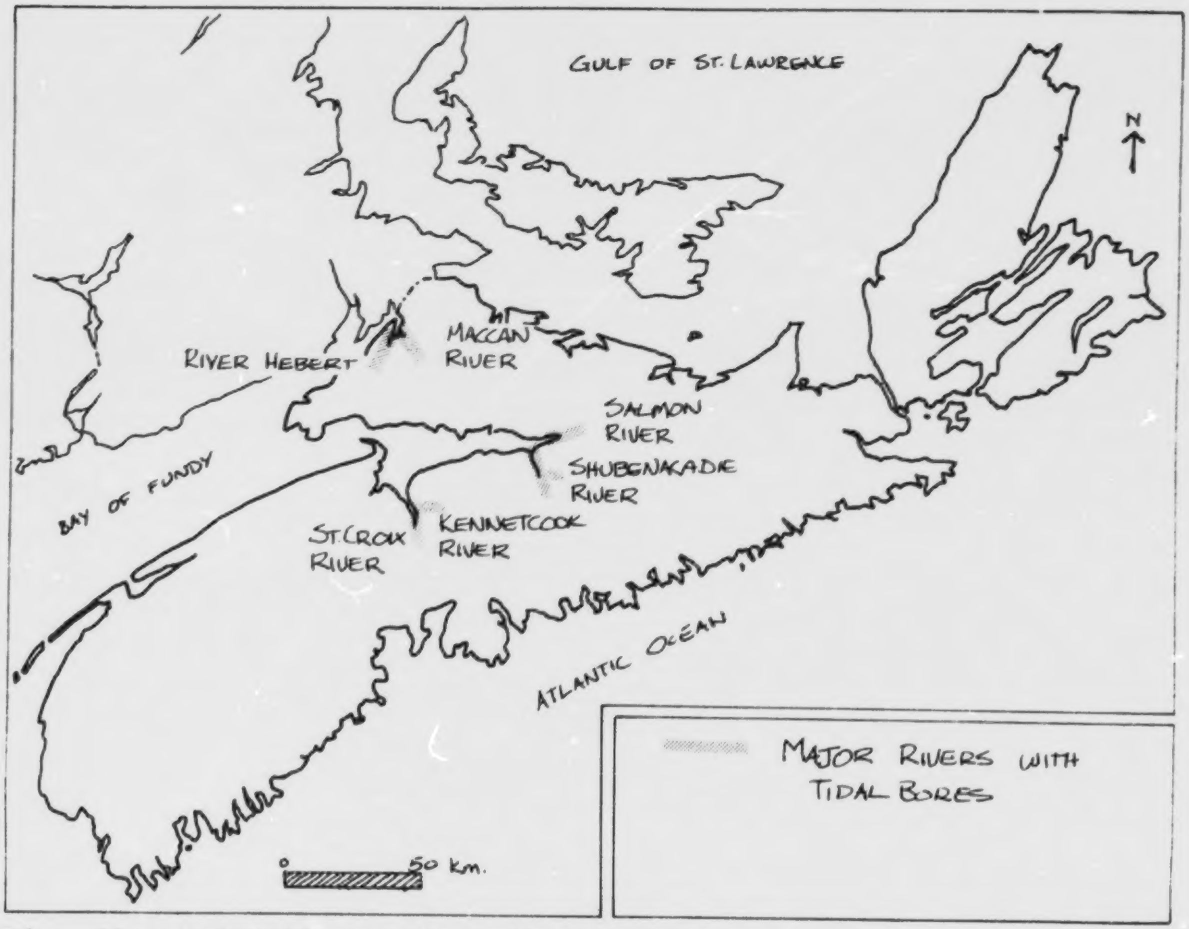

GULF OF ST. LAWRENCE
N
RIVER HEBERT
MACCAN RIVER
SALMON RIVER
SHUBENACADIE RIVER
BAY OF FUNDY
ST. CROIX RIVER
KENNETCOOK RIVER
ATLANTIC OCEAN
MAJOR RIVERS WITH TIDAL BORES
0
50 km.

Fig. 40. Major Rivers with Tidal Bores in Nova Scotia.

Large tidal amplitudes also produce strong tidal currents, with increased erosion and sediment transport potential. This in turn can result in very turbid waters, with low light penetration, disturbance of bottom material by ice dragging over submerged mudflats and lower productivity. Strong tidal currents may also produce vertical mixing, and therefore inhibit thermal stratification in summer. In the upper Bay of Fundy the water coming in over the mudflats gets very warm in summer, but the deeper water in the outer Bay stays very cool because of the mixing due to tidal currents. A very steep temperature gradient results. One consequence is that the summer fog common over the Fundy coasts west of Minas Basin rarely penetrates into Cobequid Bay or Cumberland Basin.

The tidal amplitude affects estuarine environments, helping to determine the extent of the estuarine zone. The size of the tides, together with the shape of the estuary basin and the freshwater input, also affects the degree to which salt and freshwater mix, the flushing rate, and the amount of energy available in the system to move around sediment and nutrients.

Tidal amplitude also affects the temperature exchange between land and water. A high tidal amplitude combined with a shallow-sloping bottom, as in the upper reaches of the Bay of Fundy, will maximize heat exchange.

Where the diurnal tide is dominant, as at certain times along the Northumberland Shore, the inter-tidal environment will tend to be more stressful for organisms. Most inter-tidal organisms are essentially marine in origin, but can survive in the open air. When there is only one high tide daily, or the second high tide is much smaller, the time of exposure will perforce be much longer.

ASSOCIATED TOPICS

T23 Oceanic Environments, T24-28 The Coastline

ASSOCIATED HABITATS

H1-2 Offshore Habitats, H3-7 Intertidal Habitats

REFERENCES

Desplanque (1973)
Ingmanson and Wallace (1973)
Roland (1982)

T23 Oceanic Environments

The Gulf of St. Lawrence

The Gulf of St. Lawrence is an inland sea, and as such its surface waters are subjected to extreme temperature changes. Conditions are influenced by freshwater flow from the St. Lawrence and by flows in and out of the Strait of Belle Isle and the Cabot Strait. In the winter a two-layer system exists with a thick cold layer overlying deep, warmer water which flows in through the Cabot Strait (Figure 41). The cold layer has temperatures of less than 32°F (0°C) and associated salinities of between 32 and 34 parts per thousand. This cold layer is formed by cooling in situ rather than by influxes of polar water. The deep "warm" layer has temperatures as high as 41°F (5.6°C) and salinities over 34 parts per thousand.

In the spring a warm surface layer develops on top of the cold layer, which persists at moderate depths. This surface layer is practically homogenous in temperature and salinity and can be as much as 180 feet (54 m) in depth. Temperatures can range from 29.5 to 69°F (-1.8 to 20.0°C) and higher. In the open Gulf salinities range between 26 and 32 parts per thousand, but may be lower in bays and estuaries. As the summer progresses the surface layer becomes thinner. In the southwestern area of the Gulf this actually results in decreasing salinities, for although the freshwater discharge from the St. Lawrence is at its lowest, it is now mixing with a thinner layer of sea water and therefore having more impact.

In the Magdalen shallows and the Northumberland Strait the difference between summer and winter temperatures is even more pronounced because of the interaction between tidal patterns and the shallow sloping bottom already described. Changes in the wind direction and strength may also alter the relative positions of the water layers, resulting in sharp temperature and salinity changes. For this reason the southwestern area of the Gulf may be considered a biologically stressful environment.

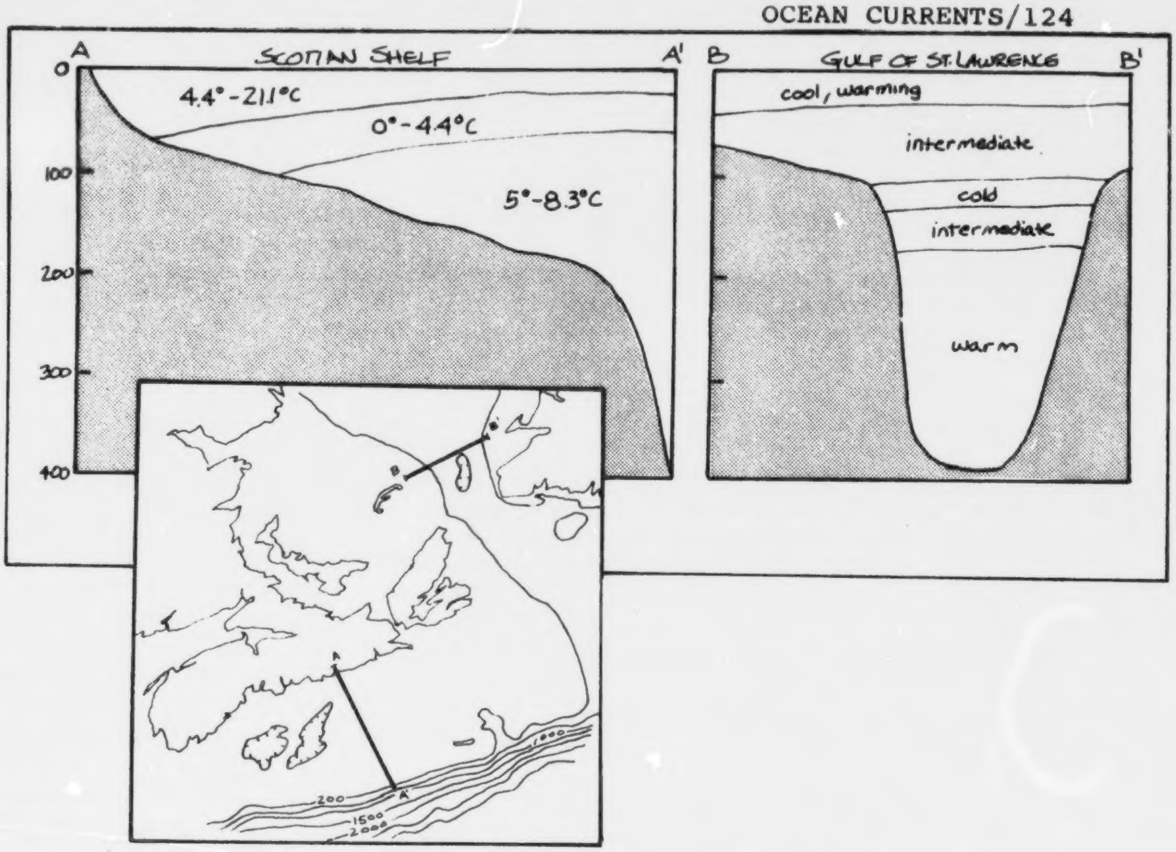

A
SCOTIAN SHELF
A'
0
100
200
300
400
4.4°-21.1°C
0°-4.4°C
5°-8.3°C
B
GULF OF ST. LAWRENCE
B'
cool, warming
intermediate
cold
intermediate
warm
B
B'
A
A'
200
1000
1500
2000

Fig. 41. Summer Stratification of Ocean Waters; Scotian Shelf (left) and Gulf of St. Lawrence (right). Brookes (1972)

Scotian Shelf Moving outwards from the Atlantic Coast of Nova Scotia four distinct bands of water are crossed (See Figure 42). The Scotian Shelf is normally covered by relatively fresh coastal water. Next to this is a band of slope water, which is a mixture of Atlantic water diluted by approximately 20 percent coastal water. Beyond the slope water lies the Gulf Stream and then true Central Atlantic water.

The coastal water on the Scotian Shelf is strongly stratified, especially in the summer. Three layers are definable:

1) An upper warm "fresh" layer, which may be up to 250 feet (72 m) thick, with temperatures of 40-70°F (5-20°C) and salinities of less than 32 parts per thousand.

2) An intermediate cold layer, between 100 and 450 feet (30 and 140 m) in thickness, 32-40°F (0-4°C) and with salinities from 32 to 35 parts per thousand.
3) A warm saline bottom layer, located at depths between 300-650 feet (90 and 195 m), with temperatures between 40 and 45°F (5 and 8°C), and salinities up to 35 parts per thousand.

The inshore waters consist almost entirely of the "fresh" upper layer, but, as atmospheric disturbances can cause the thickness of this layer to fluctuate, bottom temperatures may vary extensively with exposure to the cold intermediate layer. This cold layer is similar to the one found in the Gulf of St. Lawrence, but is created chiefly by transport of cold waters by the Labrador Current rather than by *in situ* cooling. Temperatures in the warm bottom layer may rise as high as 55°F (12°C) with incursions of slope water.

Studies of primary productivity on continental shelves usually indicate a gradual decline in biological activity with increasing distance from land. On the Scotian Shelf the reverse is true, with a band of higher than average productivity being located along the edge of the shelf. This is attributed to vertical mixing of nutrient rich slope water with the coastal water along a variable front, which may span many kilometres. It is estimated that sporadic incursions of slope water provide approximately 20 percent of the nutrient requirements for phytoplankton production, while recycling accounts for the remaining 80 percent. While the exact mechanisms are not yet certain, it appears that wind and tidal forces, and movements of the Gulf Stream, all play a role.

Gulf of Maine

The Gulf of Maine contains fairly typical coastal water with intermittent incursions of warm, saline slope water and of still warmer and more saline tropical water from the Gulf Stream. The tidal currents in this area are strong enough to promote active mixing and stratification is not found in the northeastern section of the Gulf.

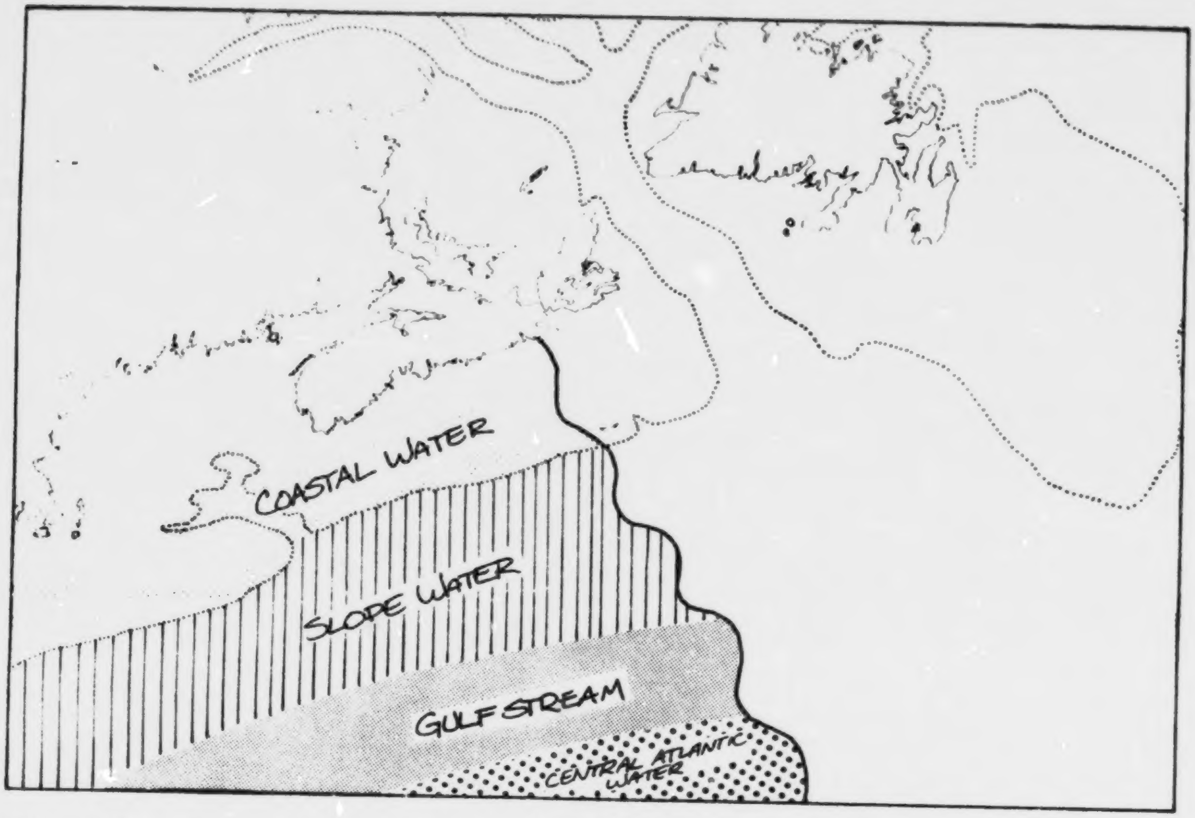


Fig. 42. Classification of Ocean Water off the Atlantic Coast. Hachey (1961)

Bay of Fundy	The dominant influence in the Bay of Fundy is that exerted by the phenomenally large tides. The subsequent mixing of waters with different characteristics tends to modify seasonal temperature variations, and to create a water column that is fairly uniform in temperature and salinity. This mixing, coupled with ample sediment sources, makes the water quite opaque, which is an important factor in limiting productivity.

ASSOCIATED TOPICS

T21 Ocean Currents, T22 Tides, T61 Marine Fishes, T63 Marine Invertebrates.

ASSOCIATED HABITATS

H1-2 Offshore Habitats

REFERENCES

Fournier (1977)
Hachey (1961)
Leim and Scott (1966)
Smith _et_ _al_ (1978)

THE COASTLINE

T24 Modifying Forces

The coast is a place of constant change. Winds, waves, tides and ice are constantly at work eroding, transporting and depositing the rock, gravel, sand and mud of the shore. On the Atlantic coast waves are the most important environmental agent of change, while in the Bay of Fundy tides, and the currents generated by them, are of greater significance. The ice which covers the Northumberland Strait up to four months of the year reduces the effectiveness of waves but is an important agent of change in itself. Sable Island (region 900) is best considered as a separate coastal environment in which the full force of oceanic winds, waves and currents maintain unique landforms.

Landforms which result from these forces depend very much on the bedrock geology, unconsolidated surficial materials remaining from the last glaciation, and sea level changes in the post-glacial period. For purposes of this description bedrock can be grouped into resistant and unresistant types. Resistant rocks dominate the Atlantic coast, region 800, (except in southern Cape Breton Island), the Bay of Fundy coast west of Cape Split (region 700) and the Antigonish-western Cape Breton Island section of the Gulf of St. Lawrence (districts 220 and 310). Beaches and marshes in these areas are derived exclusively from reworked surficial sediments including eroded drumlins, glacial outwash and marine deposits. These beaches and marshes are therefore of limited extent and size. Unconsolidated bedrock outcrops in the Northumberland Strait (district 520), southern Cape Breton Island (districts 530 and 870) and the upper reaches of the Bay of Fundy (region 600) are sources of relatively abundant coastal sediment. Surficial deposits also tend to be more plentiful in these areas. As a direct result the largest beaches and marshes are found on these coasts.

All coastlines in Nova Scotia are eroding. Rising sea level over the last 15,000 years has caused the coast to retreat inland, flooding the lower reaches of river valleys, eroding unresistant bedrock and unconsolidated materials to create marine platforms, raising marsh levels, and pushing beaches landwards.

Waves	Ocean swells from the south and east dominate the Atlantic coast. This high energy

environment is more pronounced in winter. In the fall remnants of hurricanes often cross the province and its coastal waters from the southwest. Significant wave height occurring once a year varies from 18 feet (5.5 m) in the Gulf of Maine to 22 feet (6.6 m) off Halifax and 24 feet (7.2 m) off Cape Breton Island. Off-shore winds may reduce these wave heights and their effect on the shoreline, but even off Halifax, which experiences predominantly northwest and northerly off-shore winds in the winter, waves erode unconsolidated drumlins at Hartlen Point at a rate of 6 feet (2 m) annually. On all coasts except the Atlantic, on-shore winds generate waves. Swells from the open ocean lose their significance as they enter the Bay of Fundy and are not important in the Gulf of St. Lawrence. Locally generated waves in the Gulf produce significant wave heights of 25 feet (7.6 m), occurring once a year, higher than those in the ocean. Summer winds from the southwest and winter winds from the northwest generate waves in the Bay of Fundy. These have combined with the tides to erode wave-cut platforms on west facing coasts. In the Gulf of St. Lawrence predominantly westerly winds and northeast storm winds generate waves of sufficient energy to erode unresistant bedrock outcrops at 3 feet (1 m) annually.

A noticeable seasonal cycle in wave energy is observed in the Atlantic Ocean, Bay of Fundy and Gulf of St. Lawrence (although the Gulf is protected by ice from December to April). The increased winter wave energy, especially in storm episodes, combs down beaches removing sand and gravel off-shore and destroying the characteristic series of parallel off-shore bars. Persistent, but gentler, on-shore winds in the summer move the same material shorewards, rebuilding the beaches and bars.

Tides

Tidal range is only 3 to 6 feet (1-2 m) in the Northumberland Strait. At certain times only one tide occurs in the Northumberland Strait (see T.22). In summer the low tide occurs during the day exposing beaches and sand bars to the sun's radiation. The incoming tide is warmed as it moves over these sand flats, raising water temperatures to the highest values achieved in Nova Scotia. In winter the reverse situation occurs, the sand flats are exposed at night, the incoming tidal water is chilled, greatly aggravating the ice conditions.

Tide ranges of large tides increase westward on the Atlantic coast from a large tide of 4.5 feet (1.4 m) at Ingonish to 6.5 feet (1.95 m) at Guysborough and 7 feet (2.1 m) at Halifax. Narrow entrances restrict tidal influence in the Bras d'Or Lake; in the "lake" itself the range at Baddeck is less than 6 inches (0.2 m). However strong tidal currents and barometric tides result in the mixing of fresh and salt water in the Bras d'Or Lake. Currents of 10 feet/sec (3 m/sec) and 5 feet/sec (1.5 m/sec) are measured in the Great Bras d'Or channel and the Barra Strait.

With the rapid increase in tidal range and height within the Bay of Fundy, stronger tidal currents are established and the capacity to perform work increases. Large tides have ranges of 17 feet (5.1 m) at Yarmouth, 31 feet (9.3 m) at Digby, 42 feet (12.6 m) at Advocate and 53 feet (16.0 m) in Minas Basin. Currents are greater than 3 feet/sec (1 m/sec) in the off-shore waters and have been reported in excess of 16.5 feet/sec (5 m/sec) in the Minas Passage. River estuaries in the Bay are dry at low tide but at high tide water levels are even higher than in Minas Basin reaching 33 feet (10 m) above mean sea level. Stronger currents generated by the flood tide carry fine sediment into these estuaries, which the weaker ebb tidal currents are unable to remove. This is the origin of sediments which have built, and are building, the marshes at the heads of Chignecto and Cobequid Bays. The strongest currents in the main channels carry and deposit sand, forming gigantic sand bodies characterized by sand waves. Particularly conspicuous sand bodies are found in the Avon estuary off Hantsport, in Cobequid Bay west of the Shubenacadie estuary, and off Economy Point. This sand is only exposed at low tide.

Ice

Only in the Gulf of St. Lawrence does sea ice cover large areas of water. Shore ice begins forming in December and by late January covers much of the Northumberland Strait. Not until late March or April does this ice break-up and move through the Cabot Strait to the Atlantic. The ice cover is moved by strong winds and in piling up on windward shores protects the coast from wave attack, although the ice itself may 'raft' material from beaches and marshes. During break-up strong currents moving ice along the Atlantic coast of Cape Breton Island cause ice scour removing sediments, vegetation and animals southwards and off-shore. On a much reduced scale ice forming on mud flats in the Bay of Fundy may protect the coast from erosion by waves and tidal currents, but also transports material which becomes frozen into the ice flows. Local ice forms in bays on the Atlantic Coast but does not produce major change in coastal landforms.

ASSOCIATED TOPICS

T21 Ocean Currents, T22 Tides, T23 Oceanic Environments, T25 to T28 The Coastline

REFERENCES

See T28 Offshore Bottom Characteristics

T25 Sea Level Changes

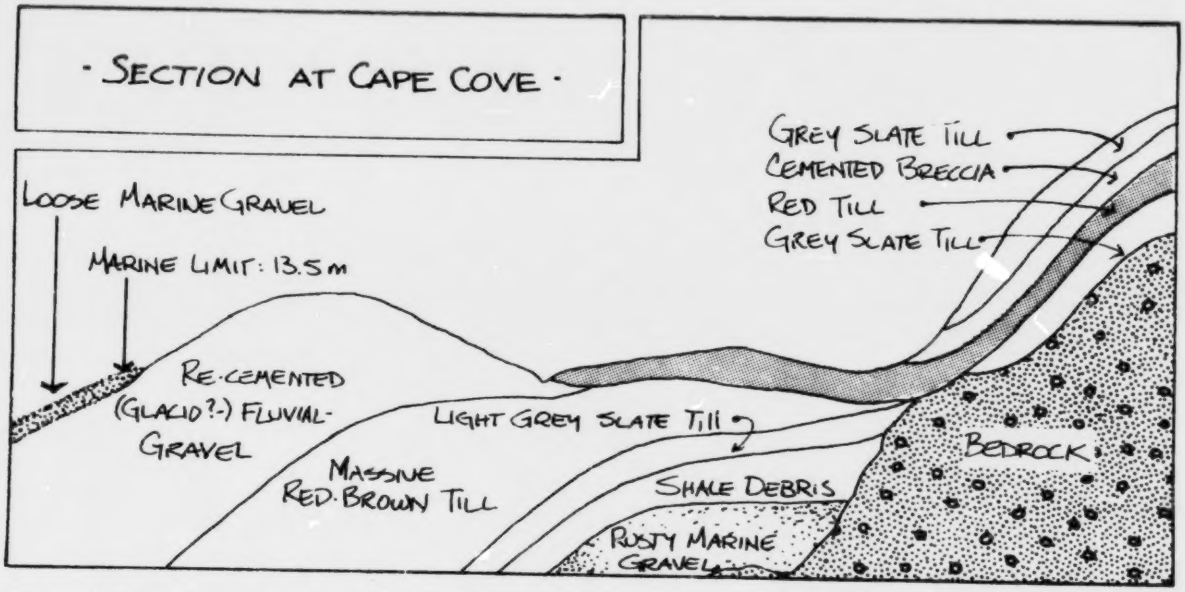
Since the last recession of glacial ice 12,000-14,000 years ago world wide sea level has been rising, at a fast rate until about 6,000 years ago, and at a much slower rate since then. World wide sea level is now rising about 2 inches/century (5 cm/century). Nova Scotia is subsiding about 10 inches/century (25 cm/century) (slightly more in the Bay of Fundy) giving a total rate of submergence of 12 inches/century (30 cm/century).

The Bay of Fundy was greatly depressed by the weight of glacial ice, so that as the glacial ice melted sea water flooded on to the present land surface. As the mass of glacial ice on land and coastal waters melted, the pressure was released and the surface rose. This isostatic uplift extended the land surface of Nova Scotia into the Bay of Fundy. Then, about 6,000 years ago, the rising sea level and a depression of the crust combined to allow the ocean to flow back on to the land. The remainder of Nova Scotia was not depressed to the same extent. On the Atlantic coast sea level was lowest at the maximum advance of glacial ice. A prominent submarine terrace was cut by this sea level about 400 feet (120 m) below present sea level. Since 15,000 years ago the sea has risen continually transgressing across the Scotian shelf. In the less resistant rocks of the Northumberland Strait a series of submerged terraces may be found, documenting successive sea levels of the post-glacial period.

Ancient Shorelines

In the western and northern extremities of Nova Scotia an elevated shoreline is found. This terrace, or bench, cut in the bedrock is a distinctive landscape feature in St. Marys Bay (district 820) and on the east and west of northern Cape Breton Island (districts 550 and 590). In St. Marys Bay it is assumed to be 100,000 years old, and to have been formed in a warmer inter-glacial period. This age is assumed as extensively weathered glacial tills are found on the bench, as shown in Figure 43. Elevation of this ancient bench above present sea level is only slight, averaging 12-20 feet (4-6 m).

By inference the ancient wave cut terrace near Cheticamp in the Aspy valley (north of St. Margaret Village), which is at a similar elevation, is the same age. Remnants of what is probably the same platform are found around Cape George, Antigonish County.



· SECTION AT CAPE COVE ·
LOOSE MARINE GRAVEL
MARINE LIMIT: 13.5m
RE-CEMENTED (GLACIO?-) FLUVIAL-GRAVEL
MASSIVE RED-BROWN TILL
LIGHT GREY SLATE TILL
SHALE DEBRIS
RUSTY MARINE GRAVEL
BEDROCK
GREY SLATE TILL
CEMENTED BRECCIA
RED TILL
GREY SLATE TILL

Fig. 43. Section at Cape Cove, Digby County: A Record of the Acadian Glaciation. Grant, D.R. (1980)

- Marine gravel: deposited in immediate post-glacial time, higher sea level.
- Cemented fluvial gravel: outwash materials deposited during glaciation.
- Red-brown till: glacial till from New Brunswick, regional advance, 100,000 years ago
- Light-grey slate till: locally derived till, indicating early and late local ice caps.
- Debris: angular fragments from periglacial conditions prior to ice advance.

  Marine gravel (rusty): deposited prior to last glacial advance.
- Marine platform: fossil wave-cut platform, just above present sea level, backed by fossil cliff, 120,000 years ago and earlier.

Land Bridges

It is possible that a strip of unglaciated land or a series of islands on the outer continental shelf joined Nova Scotia to New England during the last general glacial ice advance. Evidence for this comes from fresh-water peat dredged from depths of 325 feet (100 m) in the Gulf of Maine and mastodon teeth found at similar depths. This connection would have been flooded about 15,000 years ago during the initial rapid rise of sea level. World wide sea level is now rising about 2 inches/century (5 cm/century). Nova Scotia is subsiding about 10 inches/century (25 cm/century) giving a total rate of submergence of 12 inches/century (30 cm/century).

Marine Limit

The maximum inland penetration of the post-glacial sea level is marked by relic coastal features similar to those now found at the shoreline. These features are confined to the north and west of a line joining Yarmouth, Windsor, Truro and Northport. The marine limit is highest on Digby Neck (district 810). At Brier Island well preserved beaches are found at 120 feet (36 m) above mean sea level. At Sandy Cove a wave cut cliff exposes 135 feet (40 m) of stratified sand and gravel, the top of which has been levelled by wave erosion. To the south and east the limit declines in altitude. A delta on the Sissiboo River at Weymouth is 85 feet (25 m) high, at Smith Cove stratified materials reach 110 feet (33 m). In Kings County raised beaches near Woodside are 85 feet (25 m) high and 3.5 miles (5.5 km) inland from the present coast. At the same times as these beaches were being formed lowlying areas of the modern Annapolis Valley were submerged. Marine clays were deposited in these submarine basins. Near Bridgetown and Lawrencetown these clays are now exposed and have been mapped as Lawrencetown and Fash soils in Annapolis County.

On the Cobequid shore a series of conspicuous raised beaches reach a maximum height of 135 feet (40 m) above present sea level at Advocate, where a replica of the present harbour deposits is found on the hillside behind the village. At Parrsboro the raised beaches are 75 feet (22 m) high. The marine limit declines to present sea level at Truro.

It is assumed that south and east of the line joining Yarmouth, Truro and Northport, post-glacial sea levels have never been higher than they are at present. This tilting of the land mass is evidence for a greater glacial depression of the land in the Bay of Fundy area than in eastern Nova Scotia.

Buried Valleys

Lower sea levels from 15,000 to 8,000 years ago, and probably from earlier periods, caused the rivers to extend well beyond the present estuaries. In some cases where the rivers flow over easily eroded rocks, especially the Triassic sandstones of the Bay of Fundy, the river valleys were cut down deeply into the bedrock. Buried valleys in the bedrock have been found at Truro, Brookfield and in the Annapolis Valley. Both the North and Salmon Rivers at Truro have similar buried valleys, extending 3.75 miles (6 km) and 5 miles (8 km) respectively under the present flood plain north of Truro. In places the channel of the Salmon River reaches 135 feet (40 m) below the present land surface. Buried channels in the Truro and Kentville areas are filled with glacial outwash sands and gravels.

Submergence

Sometime before 8,000 years ago in the Bay of Fundy, and before 15,000 years ago elsewhere in Nova Scotia the sea once again began to encroach upon the land. Forests had developed on the exposed sea floor, which was probably a maximum of 100 feet (30 m) below present sea levels in the Bay of Fundy.

Probably the most dramatic evidence of sea level change are the submerged forests to be found on the Atlantic and Bay of Fundy coasts. Examples occur in Chignecto Bay at Fort Lawrence and at Boot Island in Minas Basin. Pine and Beech stumps more than a metre in diameter occur at these sites, and are well rooted in podzol soils resembling those of the surrounding uplands. On the soil surface a forest floor humus of partly decomposed leaves, twigs and cones can still be found. A typical site is illustrated in Figure 44.

On the Atlantic coast many scattered examples occur, extending in places well beyond the low tide level. Well known examples are Yarmouth Harbour, Sunday Point, Cape Sable Island, Lunenburg and McNabs Island in Halifax Harbour.

Most of these stumps are between 5,000 and 3,000 years old. It has been deduced that their submergence was due largely to recent crustal subsidence, which over the last 4,000 years has averaged 12 inches (30 cm) per century. In the Bay of Fundy an increase in tidal range has also aggravated the rate of subsidence.

Formation of the Fundy Marshes

Submergence of the Bay of Fundy in the last 6,000 years has caused rapid and extensive erosion of sea cliffs. A wave-cut platform varying in width from 20,000 feet (6,000 m) to 3,500 feet (1,000 m) has been formed. The result is an estimated annual supply of 100 million cubic feet (3.1 million m^3) of sand into Minas Basin and 50 million cubic feet (1.6 million m^3) of silt and clay into the Bay of Fundy. Material is transported towards the heads of the bays by tidal currents both along the bottom and in suspension.

The result has been the deposition of the extensive marshes at the heads of the bays. These marshes continue to increase in elevation in response to the rising sea level and to transgress inland. At the eroding outer edge of the marshes upland vegetation, forests and bogs are continually revealed, as described above.

20th Century Sea Level Changes

Analysis of tide gauge records at Halifax, Saint John and Charlottetown indicates a fairly steady rise of 16 inches/century (41 cm/century), 18 inches/century (46 cm/century) and 10 inches/century (26 cm/century), respectively. Geodetic levelling has confirmed this, indicating a depression of the crust south-east across the Maritimes from the St. Lawrence River. Maximum depression of the crust is in the Amherst to Truro area of the Bay of Fundy.

ASSOCIATED TOPICS

T13 Glaciation, T14 Deglaciation and Glacial Deposits, T15 Postglacial Climatic Change, T24 Modifying Forces.

REFERENCES

See T28 Offshore Bottom Characteristics

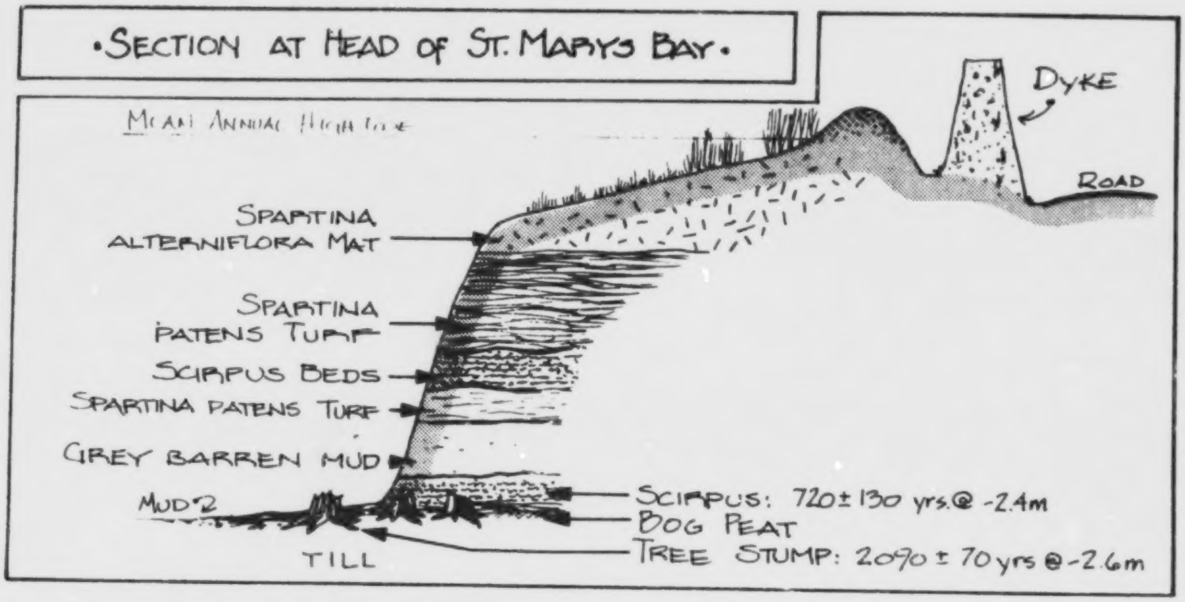

•SECTION AT HEAD OF ST. MARYS BAY•
MEAN ANNUAL HIGH TIDE
DYKE
ROAD
SPARTINA ALTERNIFLORA MAT
SPARTINA PATENS TURF
SCIRPUS BEDS
SPARTINA PATENS TURF
GREY BARREN MUD
MUD 2
TILL
SCIRPUS: 720 ± 130 yrs. @ -2.4m
BOG PEAT
TREE STUMP: 2090 ± 70 yrs @ -2.6m

Fig. 44. Relationships of Submerged Forests to Recent Salt Marsh Deposits, Bay of Fundy.
Grant (1980)

T26 Coastal Landforms

A great variety of coastal landforms are found in Nova Scotia. Erosional features are predominant, but the landforms produced vary according to the geology and glacial history. Depositional landforms, beaches and marshes, are being formed as a result of erosion and transportation of unconsolidated material. But many of these deposits are, in turn, being eroded by the rising sea level. These descriptions of coastal landforms should be read in conjunction with the habitat descriptions.

ROCKY SHORES

Where resistant rocks occur there may be neither cliffs nor unconsolidated material from which beaches or marshes can be formed. The only significant physical process in such circumstances is the hydraulic "quarrying" of large blocks by storm waves, any glacial till overburden having been simply swept off the shore by large waves. Two types of rocky shores without cliffs can be recognized: granitic rocks and Meguma rocks, principally quartzite. Both are part of the gently seaward dipping surface of the Atlantic Upland. Only where less resistant volcanic rocks occur at Louisbourg and Fourchu (Yarmouth County) are sea cliffs formed.

The granite headlands of the Atlantic coast have been little changed by their submergence and exposure to waves. The thin cover of glacial till has been removed to expose the glacially smoothed bedrock. The gradual seaward slope of the land continues under the ocean without interruption, the pounding waves having barely altered these resistant rocks. Where the granite is more heavily jointed waves have been more effective in excavating large blocks.

In quartzites of the Meguma group joints are more closely spaced. As a result "quarrying" has been more effective. Modification of these rocks has not been sufficient to produce cliffs, but tide pools are more numerous, especially where the rocks outcrop parallel to the coast as on much of the Eastern Shore.

CLIFFS

In less resistant rocks, such as sandstones, shales, basalt and in unconsolidated materials, especially drumlins, cliffs are being formed. Ancient cliffs, formed over long periods before the last ice advances and often related to structural weaknesses such as fault lines, are present especially in northern Nova Scotia. This can be attributed to the general tilting of the province to the south-east.

Notable ancient cliffs are found in Cape Breton north of the Margaree Valley on the west coast (district 220). On the Mainland, Cape George (district 310) is a southerly extension of this same geological structure. Northern limits of the southern upland Meguma rocks form seacliffs on the south side of Chedabucto Bay (unit 862), which is a fault line scarp, and the south side of St. Mary's Bay where the strike parallels the coast (district 820). The presence of raised beaches, known to have been formed at least 120,000 years ago in St. Marys Bay, attests to the ancient origins of these high cliffs in resistant rocks.

The most rapidly eroding cliffs are those in partially submerged drumlins on the Atlantic Coast (district 830) and in unresistant horizontal sandstones of the Bay of Fundy (region 600), Northumberland Strait (district 520) and the Sydney coalfield (district 530). Maximum rates of retreat have been reported as follows:

Five Islands Amos and Long (1980)	5 feet (1.5 m)/year
Minas Basin Churchill (reference in Amos and Long)	6.5 feet (2.0 m)/year
Glace Bay Roland (1982)	8.5 feet (2.6 m)/year
Cape LaHave Piper (1980)	8.0 feet (2.5 m) year
Hartlen Point Gosselin (1972)	7.5 feet (2.3 m) year

Mean rates for the Bay of Fundy are about 1.5 feet (0.5 m) a year and for exposed Atlantic coast drumlins are about 3 feet/year (1.0 m/year). Eroded drumlins are marked by a lag deposit, just below low tide level, of the larger boulders. All other material has been winnowed from the drumlin and redistributed. As long ago as 1929 Johnson attempted to recreate a map of the former drumlin field in Mahone Bay (district 460) from hydrographic charts of shoals. He mapped nearly 60 shoals or lag deposits which must have been drumlins within the past 10,000 years, and there are many other bars and small islands which may at one time have been drumlins.

In contrast, the erosion of bedrock cliffs in the Bay of Fundy, Northumberland Strait and Cabot Strait creates a wave-cut platform in the bedrock as the cliff recedes. These wave-cut intertidal platforms are considered in more detail in the following section. The nature of the cliff face and the platform both depend on the dip of the rocks. Predominantly horizontal sedimentary strata in Cobequid Bay, Cumberland Basin, Northumberland Strait and Cabot Strait result in near vertical cliffs and smoothly sculptured intertidal platforms. Where the structure is vertical as in Bay of Fundy basalts or in sedimentary strata west of Parrsboro, vertical cliffs may again be formed but with a more irregular platform. Inclined strata may produce overhanging cliffs if the dip is landwards as in north-west Cape Breton, or in some Meguma group slates on the Atlantic coast.

Features such as caves, arches and stacks are not common. Where erosion is rapid small variations in resistance produce such features but, by definition, they are short-lived. Conditions necessary for the formation of these erosional features are best developed in Cobequid Bay (region 600) where a dramatic arch is found at Salter Head and a series of stacks at Five Islands.

Many of the cliffs are unstable. In the glacial till cliffs which border the Northumberland Strait (district 520), slumping, especially in the spring thaw, is the predominant destructive process. Where sedimentary rocks dip seawards seepage may produce slides as in Horton shales in north-east Cape Breton (district 550). Large scale slides can also be seen in the schists north of Cap Rouge on the Cabot Trail in Cape Breton Highlands National Park (district 220). Large blocks detach themselves from the horizontally bedded cliffs of south-east Cape Breton (district 530) and in the Bay of Fundy. Huge masses of rubble accumulate at cliff foots in Triassic basalt as frost shatters the vertical structure.

The highest actively eroding cliffs in Nova Scotia, in Advocate Bay at Cape Chignecto, are 700 feet (210 m) in height (district 310). Other high cliffs are on Cape Split, 250 feet (80 m), and Cape Blomidon 600 feet (180 m) (district 720).

INTERTIDAL WAVE-CUT PLATFORMS

As cliffs recede a gently upward sloping bench is cut into the bedrock. Waves cut this bench by removing cliff-foot debris, scouring fragments against the cliff-foot and across the platform, through wave "quarrying" in storms and by chemical disintegration in the spray zone. Since wave attack is controlled by the limits of tidal action, it is clear that the landward and seaward limits of the platform must also be determined by tidal heights. Wide platforms are found on more exposed coasts with high energy waves and on coasts with a large tidal range. However, in Nova Scotia the highest energy coast, the Atlantic coast (region 800), is dominated by highly resistant rocks. For much of the Atlantic coast there is no marine platform and no cliffs.

In contrast, the entire Bay of Fundy coast exhibits a wide wave-cut platform cut into both basalts and the less resistant sedimentary rocks. East of Digby Gut a wide continuous platform has been cut into the basalts which form near vertical cliffs at the landward edge of the platform, up to 100 feet (30 m) in height(district 720). In Cobequid Bay the platform is even wider, reaching a maximum 20,000 feet (6,000 m) at Lower Economy (district 620). The narrowest section in the Bay is 3,000 feet (900 m) at Burntcoat Head, presumably because the sandstone is more resistant in this area. The great width and extreme rapidity with which this platform has been created and is still being extended, are due to the large tidal amplitude. In most areas the platform is partially obscured by sediments which typically show the following sequence: gravel beach, mud veneer over gravel lag, exposed gravel lag, sand bars. These sediments (Figure 45) are predominantly thin, less than 1.5 feet (0.5 m). Gravel at the cliff-foot forms a steep beach, which in places is being driven inland over salt marshes by the rising sea level. The mud veneer, in Cobequid Bay, is thin on the rock platforms and appears to thicken during the summer and to be thinned by winter ice. Near the low water level the mud becomes coarser and more extensive. Sometimes deep sand deposits obscure the platform. A gravel lag deposit, from which the finer sediments have been washed out, underlies this entire sequence in some sections.

Wide intertidal platforms also dominate the Northumberland Strait coast from Merigomish to Baie Verte (N.B.). Little research has been conducted on the formation of these platforms. Their presence is attributed to the unresistant bedrock. Sand bars are frequently found on these platforms, which have an almost imperceptible gradient.

BEACHES

Wave dominated deposits often of a predominantly single grain size from fine sand to boulders are referred to as beaches. Sand beaches occur in sediment "sinks" in which all available material from a stretch of coast known as a "cell" is concentrated. Sand beaches often contain a significant gravel element at the higher levels. Very large particles in the boulder-cobble range are generally found close to their source, usually an eroding glacial till cliff.

Concentrations of sand are formed under a great variety of circumstances which are the basis for the following beach classifications:

1. Barrier beaches and baymouth bars
2. Spits
3. Tombolos
4. Pocket beaches

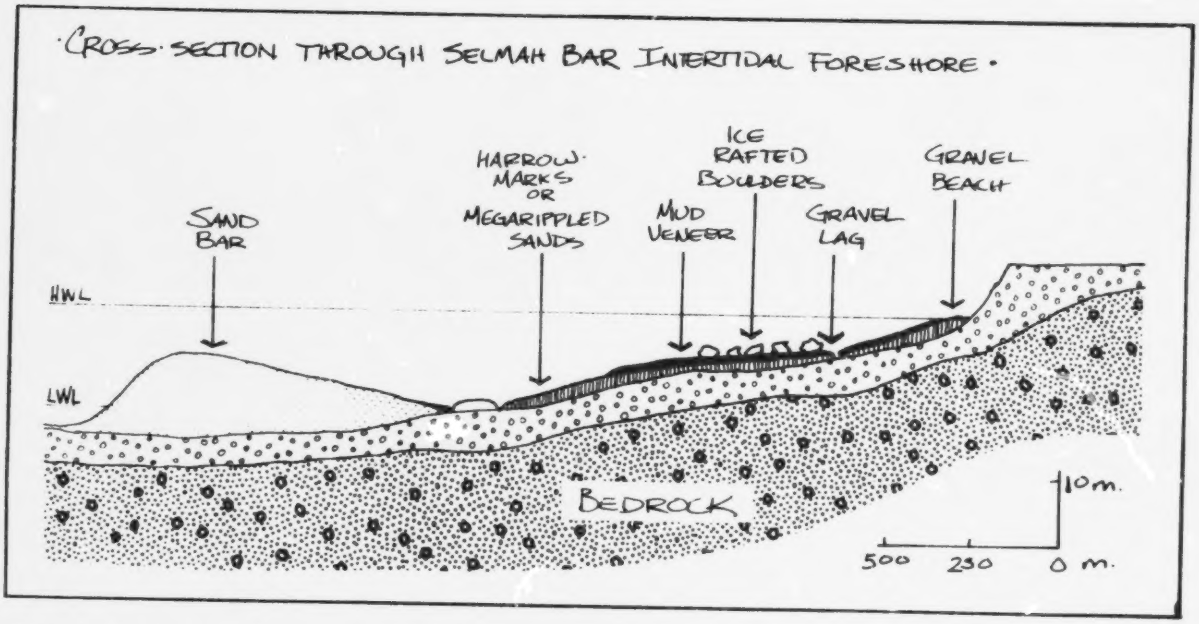

CROSS-SECTION THROUGH SELMAH BAR INTERTIDAL FORESHORE
SAND BAR
HARROW-MARKS OR MEGARIPPLED SANDS
MUD VENEER
ICE RAFTED BOULDERS
GRAVEL LAG
GRAVEL BEACH
HWL
LWL
BEDROCK
10m.
500
250
0 m.

Fig. 45 Intertidal Sediments, Bay of Fundy; Section on Selman Bar.
Amos (1980)

Barrier Beaches and Baymouth Bars

These beaches are only found in areas with abundant unconsolidated sediments. Rising sea level erodes the beach and adjacent headlands forcing a landward retreat of the beach. The adjacent headlands 'anchor' the extremities of barrier beaches. Barrier beaches are well developed in eastern Cape Breton. The sandy beaches of Bridgeport Basin and Big Glace Bay Lake (district 530) are barriers as are the pebble-cobble and sand beaches of Belfry and Fourchu on the Atlantic Coast (district 870). Large barrier beaches are found at Clam Bay, Martinique and Lawrencetown (unit 833), at St. Catherines River Bay (Cadden Bay, unit 841) and elsewhere on the Atlantic coast. These are all composed largely of relict sands accumulated during deglaciation rather than sands which are actively accumulating at present. Barrier beaches are largely absent from the Bay of Fundy, and are only found in pronounced sediment traps in Northumberland Strait at, for example, Oak Island, Caribou Island and Merigomish Island (district 521). On the more exposed Gulf of St. Lawrence coast barriers are again well developed, especially at Antigonish and Pomquet (unit 521b) and at Inverness and Pleasant Bay (units 551a and 592b).

As a result of their continuing landward migration all these beaches undergo a constant cycle of erosion, failure and rebuilding. All stages of this process may be observed at various places in the province. The Cadden Bay barrier beach has failed twice in storms during the last 50 years, a fact confirmed by aerial photography and indicated by the flat profile, absence of dunes and restricted vegetation on the beach at present. Inverness beach, by contrast, is well developed with high stable dunes and no evidence of overwash. Martinique is about to fail with recent establishment of washovers, a high erosion face in the dunes, and invasion of dune vegetation by blowing sand resulting in a reduction in diversity of shrubs and grasses in favour of dune grass. The low wave energy of the Northumberland Strait has not allowed the incipient barrier beaches to build above high tide level, but has maintained an almost horizontal sub-tidal profile over large areas, as at Oak Island. At the eastern end of the Strait, which is more exposed, higher wave energy has allowed the emergence of the barrier beaches. The best example, at Merigomish, is also failing, with washover ocurring in most major storms.

Spits

Spits are created by the movement of sediments along the shore by waves and, in the Bay of Fundy and Bras d'Or Lake, tidal currents. At points where there is an abrupt change of shoreline orientation or the currents diminish, sediment is deposited. Many of the barrier beaches have been initially formed by the coalescing of spits forming from opposite directions, or by the complete closure of a bay by material moving in one direction. Coalescing spits have formed the beaches at Advocate Harbour and West Apple River, Cumberland County, and at Cole Harbour, Halifax County, and South Harbour, Ingonish, while materials moving from one direction have formed barriers such as Merigomish Island, Mabou Harbour and Martinique Beach.

Beaches exhibiting the classic features of spits, including the recurved downdrift extremity are uncommon. One of the best is at St. Anne's Bay and another is in Barrington

Bay. Probably the best classic examples of spits are on the north shore of Minas Channel and the supra-tidal elements of the barrier bar system at Oak Island on the Northumberland Strait. The two spits extending westerly from the island fail to form a permanent connection with another southerly extending spit on the mainland.

Where currents meet on straight shorelines spits may coalesce to form a triangular beach enclosing a small lagoon. These 'barachois' ponds are especially common in Bras d'Or Lake (district 560) where the incoming and outgoing tidal currents interact.

Tombolos

Tombolos are beaches formed in the lee of islands where wave action is reduced. Frequently tombolos extend from the mainland shore to the island forming a permanent connection. Many of the larger and better known beaches are of this type; Crescent Beach in the lee of Cape LaHave Island, Partridge Island at Parrsboro, the former beach at Port Hood, and the double tombolo at Point Michaud.

Pocket Beaches

On coasts with cliffs and where sediment is scarce limited amounts of sand, gravel or cobbles may accumulate in indentations in the coastline. These beaches are always small and are generally becoming smaller as the sea level rises. The fine sand beaches on Pennant Head (Halifax County) are of this type as well as many of the steep cobble beaches on the Atlantic coast, for example on Flying Point, Martinique. Beaches of this type are also common in northern Cape Breton for example Fishing Cove and Pigeon Point Cove in the National Park.

General

While most of the beaches are eroding, retreating landwards and losing sand there are some examples of accreting beaches. Where accretion is most rapid a series of beach ridges may be built parallel to shoreline. The best example is at Pomquet Beach, which appears to be still growing despite rising sea level. Conrods Island is also composed entirely of recently constructed beach ridges but is now eroding. Just to the west, Cole Harbour beach is also accumulating both sand and gravel at a rapid rate.

Artificial changes to the shoreline are usually the most likely reason for modern beach construction. The beach at Mabou Harbour is enlarging due to the interception of northward moving sand by a breakwater, while Inverness beach is building as southward moving sand is similarly trapped. Causeway construction at Barrington has dramatically increased sand accumulation on the opposite side of Barrington Bay and completion of the road link to Caribou Island allowed subtidal deposits to build a series of beach ridges. Local beaches have been built, throughout the province, by accumulation of sand behind wharves (which have also enhanced downdrift erosion) as at Lismore, Doctors Island, Rissers Beach and in St. Marys Bay.

In other instances man's activities have contributed to significant destruction of beaches. Removal of sand and gravel for construction purposes has completely destroyed beaches near Dartmouth at Three Fathom Harbour and Cow Bay. Minimal supply of new sediments to these beaches indicates a very slow recovery. At Cole Harbour (near Dartmouth), Belfry and Framboise beaches in Cape Breton and Kings Head in Pictou County a more plentiful supply of sediment occurs. Even in these situations an excessive rate of sediment removal has produced some dramatic changes in beach morphology.

Dredging of the many ports in Nova Scotia has also caused accelerated erosion of some beaches and cliffs. At the entrance to Caribou Harbour, Munroes Island has been reduced considerably by dredging.

Changes in exposure to wave attack by erosion of offshore drumlins may result in changes to the orientation of beaches. This occurs in two main areas; Mahone Bay and Lobster Bay. One of the best known examples is Yarmouth Bar described by Goldthwait, "...here...are three groups of concentric beaches, intersecting one another in such a way as to show they were built by shore drift coming first from one side and then from the other...". The beach is currently being pushed landwards over the salt marshes earlier developed in its protection.

DUNES

Sand dunes are nowhere exceptionally well developed in mainland Nova Scotia, compared to areas surrounding the southern Gulf of St. Lawrence in P.E.I. and Newfoundland. This may be attributed to a scarcity of sand on the higher energy coasts and to lower energy environments in areas where sediment is abundant. Sable Island is discussed below.

Probably the largest mainland dunes are those at South-west Port Mouton, reportedly 50 feet (15 m) high. Elsewhere on the high energy Atlantic coast dunes are found at Rissers Beach and in Barrington Bay. On many other beaches low ridges colonized by Marram Grass are commonly referred to as dunes, but many of these backshore ridges have been thrown up by the waves with only minor additions of windblown sand. Only a few very low dunes are found in the Bay of Fundy and in the Northumberland Strait sand dunes are restricted to the more exposed easterly sections. Features referred to as dunes at Caribou Island, Merigomish Harbour, Antigonish and Pomquet are more properly classified as wave created beach ridges. True sand dunes are found at Mabou Harbour, Port Hood, Aspy Bay and Inverness where copious sand supply coincides with strong on-shore winds.

SABLE ISLAND (region 900)

In sharp contrast to the mainland, Sable Island has an abundance of sand and strong winds. As a result dunes over 80 feet (25 m) in height are found and continue to be formed. Most dunes are 15-50 feet (5-15 m) in height and occur in two ridges oriented east-west, parallel to the shoreline. These two ridges are gradually moving together, obliterating the once continuous pond between them. The northern ridge is higher and probably older than the southern ridge which is less than 10 m high. Materials are entirely sand with no native pebbles ever having been found. It appears that the central part of the island is essentially stable, but the spits at either end are very mobile and move back and forth with storm activity.

Controversy surrounds the question of the ultimate survival of the island. Some think that storms will reduce the island to a submarine bar. However recent investigation indicates that while the island has been becoming narrower through loss of sand from the south side, it has been increasing in height relative to rising sea level.

Perpetual movement of the sand dunes by the persistent strong winds has prevented the establishment of shrubs. Roland records that the 80,000 shrubs planted in 1901 had dwindled to 77 in 1913 and one in 1952. The contribution of the Sable Island ponies to this loss of shrubs and increased mobility of sand is also a matter of some controversy.

TIDAL DELTAS

In inlets to lagoons and in estuaries characterized by strong tidal currents, reworked marine sediments are commonly found on both the seaward and landward sides of the inlet where tidal currents abruptly lose velocity.

Inlets in barrier beaches, where sediments are plentiful usually exhibit tidal deltas, particularly on the landward side. Cole Harbour has almost been filled with sands in a very large flood-tidal delta. On the seaward side the ebb-tidal delta is much smaller as the sediments are continually removed by wave action. Changes to the channel immediately result in current changes, which are soon reflected in the form of the tidal delta. Tidal deltas rarely emerge above the highest high tide as their deposition is dependent on tidal currents.

While tidal deltas are a normal feature of breached barrier beaches, they are best developed in Cobequid Bay (unit 602) where exceptionally strong tidal currents occur. Flood tidal currents are strongest along the shorelines, while the ebb tide dominates the central channel in the Bay. The entire sand body reaches 3 miles (5 km) in width and is up to 80 feet (25 m) thick. Particle size decreases towards the Head of the Bay but fine sand remains the dominant sediment well into the Salmon River and Shubenacadie River estuaries. Sand is abruptly replaced by mud in embayments and in the estuaries. Six main sand bars constitute the tidal delta in Cobequid Bay and five in the Avon River estuary. The sand bars are elongated, up to 9 miles (15 km) long, approximately aligned with the tidal currents. Sand waves and megaripples dominate the surfaces of these bars.

RIVER DELTAS

The very limited amount of sediment carried by rivers and a large tidal range preclude the development of deltas in the estuaries of most Nova Scotia rivers. In Bras d'Or Lake the small tidal range has permitted the development of small deltas at the mouths of the larger rivers, particularly in Nyanza Bay and Whycocomagh Bay. These river deltas show the typical features: levees lining the main channel which extends beyond the distributory channels, little emergence above the lake level, and emergent vegetation over the entire delta.

MUDFLATS

Mudflats are composed of predominantly clay-sized particles and water, and are distinguished from salt marshes by a lack of vegetation. A more accurate sediment description in the Bay of Fundy where the largest mud flats occur would be muddy, sandy silt-flats. The lower mudflats contain more sand and silt and less water than the upper mudflats. Newly deposited flats, such as that north of the Windsor causeway, are more fluid (containing 80 percent water) than more stable flats which contain only about 20 percent water, and have virtually no shear strength.

In some circumstances the mudflats are a veneer over intertidal rock platforms, but in sheltered bays and inlets deep deposits are found, up to 80 feet (25 m) deep in places. Vegetation is only able to colonize the mudflats near the higher tide levels. When this happens further fine sediments are trapped by the vegetation, building the marsh up to within a metre of the higher high tide level. The mudflat proper forms below about 12 to 15 feet (4 or 5 m) above the mean tide level in the Bay of Fundy. Large mudflats are found in the southern Minas Basin both east and west of the Avon River estuary and in Cumberland Basin.

It has been shown that the activities, especially secretions, of marine organisms, help to stabilize the mudflats. Such activity may influence the mudflat to a depth of 30 cm.

Fine sediments composing the mudflat are derived from eroding cliffs and carried in to the upper bay by flood tidal currents. The ebb tide current is unable to carry out the same amount of sediment. Concentrations of sediment in the water have been measured at up to 10 g/litre in Cumberland Basin and up to 40 g/litre in tidal rivers.

SALT MARSHES

Bay of Fundy salt marshes can be distinguished from salt marshes on other coasts by their height, sediment distribution and organic matter. The Bay of Fundy salt marshes are mudflats raised and stablized by the effects of colonizing vegetation. The marsh surface is almost horizontal, slightly more than a metre below the highest high tide levels. As the tidal height is elevated in the estuaries the salt marshes may be formed as high as 15 feet (4.5 m) above chart datum. Reclaimed marshes in the Annapolis, Salmon, Shubenacadie, Avon, Minas Basin and Cumberland Basin areas vary in height from 26.5 feet (8.0 m) to 48.5 feet (14.6 m) depending on local tidal conditions. The relationship between tidal heights and marsh levels is shown in the following table:

Relationships of Tidal Heights and Marsh Levels in Selected Bay of Fundy Marshes

High Water* feet (metres)	Digby/Annapolis		Burntcoat Head		Hantsport	
Large Tide	31.1	(9.33)	52.6	(15.79)	51.0	(15.29)
Mean Tide	26.6	(7.99)	45.2	(13.56)	44.0	(13.19)
Mean Sea Level	15.1	(4.54)	25.1	(7.53)	23.5	(7.07)
Tidal Marsh	27.1	(8.13)	48.6	(14.59)	46.8	(14.04)

Organic matter is a small component of these marshes, which are composed of fine sands, silt and clay sized particles. The colour of the marsh soils indicate the type of sediments. Bay of Fundy marshes can be classified as "red", with better drained, coarser sediments, and "blue" finer, poorly drained sediments.

Formation of the marshes has been likened to a river in reverse. The tide flows in through the main channel, and then spills over and branches into a series of smaller channels. Levees of coarser, sandy sediment, are built on the channel margins while the fine material is deposited further from the channels. On the larger marshes fresh water may be trapped at the lower marsh elevations, adjacent to the upland on the landward side of the marsh. Rising sea level has accentuated this elevation difference, often forming a plug at the entrance to a river valley, damming freshwater inland and allowing the formation of peat deposits. Such situations are found in the Cornwallis River valley and on the Chignecto marshes (unit 523).

The large Bay of Fundy marshes are unusual in that the source of the sediments is chiefly marine. Elsewhere large salt marshes are usually formed from river-borne sediments. A copious supply of marine sediment derived from eroding drumlins in Lobster Bay, together with a large tidal range, has also caused the formation of extensive marshes in the Pubnico area (unit 831).

Marshes on the Atlantic coast and Northumberland Strait are smaller, have accumulated more slowly, and usually contain much greater amounts of organic matter. Rising sea level is driving beaches inland over the marshes at numerous locations, and in places compressed peat deposits outcrop seaward of the beach. At the inland limit the coastal spruce-fir forest is characteristically being inundated by the sea and organic deposits are slowly spreading into the forest. A fringe of bleached coniferous tree trunks killed by salt water is the normal back-drop to Nova Scotia salt marshes.

ASSOCIATED TOPICS

T4 to T8 Geology, T13 and T14 Glaciation, T22 Tides, T24 Modifying Forces, T25 Sea Level Change

REFERENCES

See T28 Offshore Bottom Characteristics

T27 Shoreline Types

Just as bio-physical classifications provided a hierarchical categorization of terrestrial and fresh water environments which proceed through regions, districts, systems and types, so the coastal environment may be similarly subdivided. Coastal landforms, previously described, are the smallest of these divisions and have not been systematically identified in Nova Scotia. Regional divisions are distinct and widely recognized as follows:

1. Atlantic coast: exposed, high wave energy
2. Bay of Fundy: large tidal range, sheltered
3. Southern Gulf of St. Lawrence: sheltered, micro-tidal, wave dominated, winter ice.
4. Sable Island: constant high energy, depositional environment.

Further subdivision of these coastal regions has been attempted by Owens and Bowen (1977) (Figure 46). On the basis of geomorphic and process characteristics the following subdivisions are made:

1. Atlantic coast
   Northeast Cape Breton Island (districts 550 and 210)
   East Cape Breton Island (district 530)
   Southeast Cape Breton Island (district 870)
   North Chedabucto Bay (district 860)
   South Chedabucto Bay (district 850 in part)
   Eastern Shore (districts 830, 840 and 850 in part)
   Western Shore (district 820)

2. Bay of Fundy
   South Shore (district 720)
   Head of the Bay (district 710 in part)
   Minas Basin (district 620)
   Chignecto Bay (units 532 and 523)

3. Southern Gulf of St. Lawrence
   Northumberland Strait (district 520 in part)
   Antigonish-West Cape Breton Island (districts 550, 220, 310, 580)
   St. Georges Bay (district 520 in part)

4. Sable Island (region 900)

Tables 1-3 identify the main characteristics of each subdivision. This approach most closely approximates the land district level of bio-physical classification, characterised by a "distinctive pattern of relief in geology, geomorphology and associated regional vegetation".

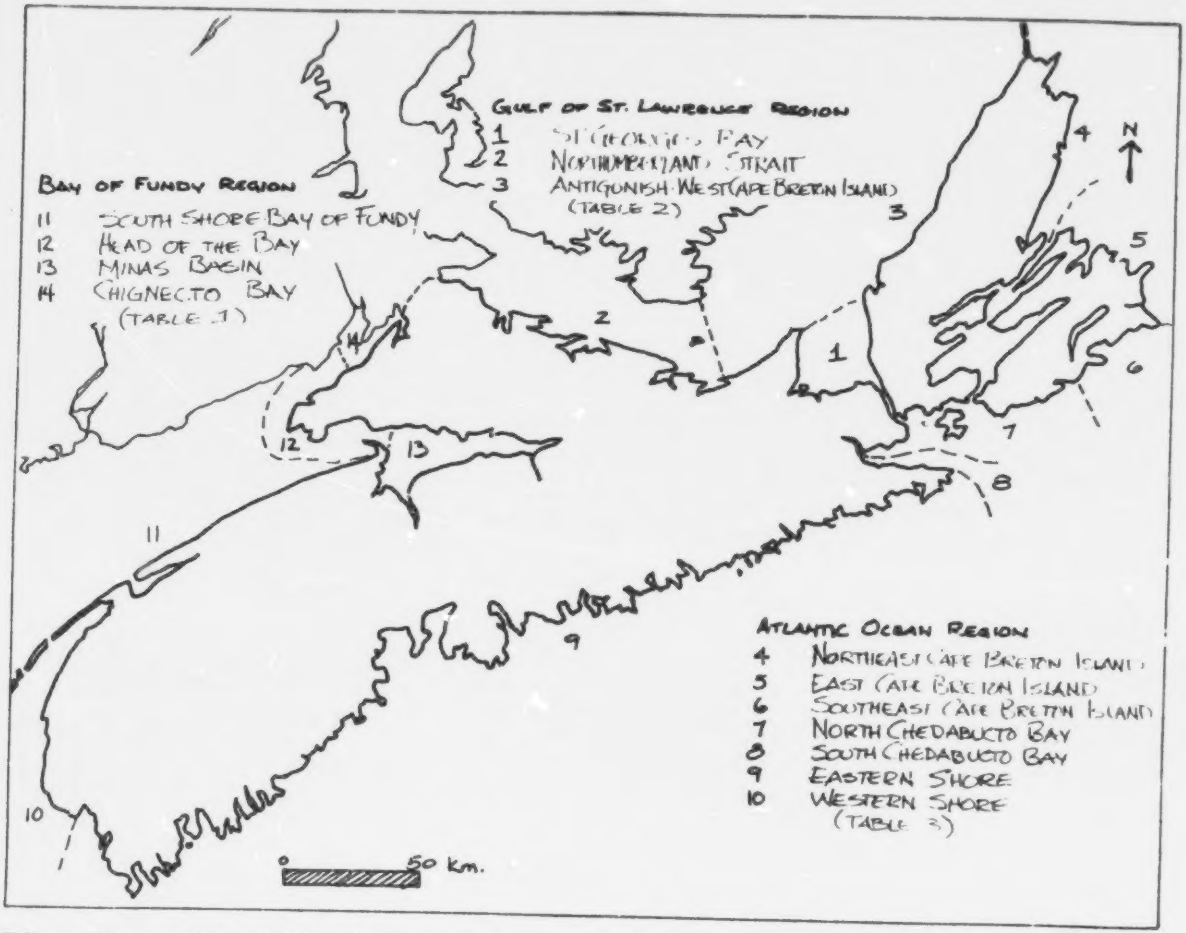

GULF OF ST. LAWRENCE REGION
1 ST GEORGES BAY
2 NORTHUMBERLAND STRAIT
3 ANTIGONISH-WEST CAPE BRETON ISLAND
(TABLE 2)
BAY OF FUNDY REGION
11 SOUTH SHORE BAY OF FUNDY
12 HEAD OF THE BAY
13 MINAS BASIN
14 CHIGNECTO BAY
(TABLE 1)
ATLANTIC OCEAN REGION
4 NORTHEAST CAPE BRETON ISLAND
5 EAST CAPE BRETON ISLAND
6 SOUTHEAST CAPE BRETON ISLAND
7 NORTH CHEDABUCTO BAY
8 SOUTH CHEDABUCTO BAY
9 EASTERN SHORE
10 WESTERN SHORE
(TABLE 3)
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
0
50 km.

Fig. 46. Classification of Coastal Environments, Nova Scotia. Owens and Bowen (1977)

Table 1. Coastal Environments of the Atlantic Coast of Nova Scotia

Subdivision	Geological Character	Backshore Relief	Beach Character	Fetch and Wave Exposure	Mean Tidal Range	Sediment Availability
1. Northeastern Cape Breton Island	Resistant metamorphic and igneous rocks; thin till cover	Upland cliffed coast (5-100 m)	Absent or narrow: coarse sediments	Exposed open ocean ocast: ice-free 8-9 months	1 m	Very scarce
2. Eastern Cape Breton Island	Carboniferous sandstone or shale; thin till cover	Rocky cliffs (5-20 m)	Occasional spits and barriers	Exposed >500 km ice-free 8-9 months	1 m	Scarce
3. Southeastern	Carboniferous sedimentary and and metasedimentary rocks; thick till and drumlins	Low rock and till cliffs (10-20 m)	Barrier beaches	Exposed open ocean coast ice in sheltered areas up to 3 months	1 m	Scarce, but locally abundant
4. Northern Chedabucto Bay	Carboniferous sedimentary rocks, some resistant volcanics, abundant till	Low rock and till cliffs up 20 m	Spits and barrier; coarse sediments	Exposed in northeast, elsewhere sheltered (<50 km) ice-free 8-9 months	1.5 m	Abundant
5. Southern Chedabucto Bay	Resistant metasedimentary and igneous rocks; fault-line coast; very thin till	Rocky cliffs (3-10 m)	Absent or narrow; coarse sediments	Sheltered (50 km) ice-free 8-9 months	1.5 m	Very scarce
6. Eastern Shore	Resistant metasedimentary and granitic rocks; variable thickness tills and drumlins	Indented low rocky coast, some eroded drumlins (30 m)	Absent or barriers or pocket beaches in re-entrants; coarse	Exposed open ocean coast, embayments sheltered: ice in sheltered areas 2-3 months	1-2 m	Very scarce
7. Western Shore	Resistant sedimentary and metamorphic rocks; thin till deposits	Till or rock cliffs (3-30 m)	Narrow or coarse-sediment barriers	Variable locally very exposed: local ice up to 2 months	4 m	Scarce, but locally

Table 2. Coastal Environments of the Bay of Fundy, Nova Scotia

Subdivision	Geological Character	Backshore Relief	Beach Character	Fetch and Wave Exposure	Mean Tidal Range	Sediment Availability
1. South Shore	Resistant Triassic basalt dyke; parallels coast	Low rocky coast or cliffs up to 30 m	Absent or narrow cobble beach at high water mark, with wide intertidal platform	Sheltered (50 km)	6-10 m	Very scarce
2. Head of the Bay	Resistant conglomerates, basalts or granites	Cliffed coast, up to 200 m	Absent or large pocket beaches pebble-cobble on beachface and mud overlying coarse seds in intertidal zone	Exposed (50-100 km)	10 m	Scarce, but locally abundant
3. Minas Basin	Triassic sandstone and shales, or unconsolidated glacial deposits	Cliffs, up to 30 m	Wide intertidal mud or sand flats on rock platform, pebble-cobble beach at high water mark, marshes in sheltered areas	Very sheltered (<50 km)	>10 m	Abundant
4. Chignecto Bay	Permo-Carboniferous sandstone and shale	Cliffs, up 20 m	Wide intertidal mud flats on rock platform, pebble/cobble beach at high water mark, extensive marshes in sheltered areas	Very sheltered (<50 km)	>10 m	Abundant

Table 3. Coastal Environments of the Southern Gulf of St. Lawrence, Nova Scotia

3. Northumberland Strait	sandstone and shale	Unresistant low relief; till, rock cliffs (3-10 m)	Barriers, spits and intertidal bars: mixed or fine-grained sediments	Very sheltered <50 km ice-free 7-8 months	1-2 m	Scarce
7. Antigonish-	Deformed sedimentary, metasedimentary and igneous rocks	Resistant rocky upland cliffed coast (5-100 m)	Absent, or narrow gravel-boulder beaches	Very exposed >300 km ice-free 7-8 months	<1 m	Very scarce
2. St. Georges Bay	Metasedimentary and sedimentary rocks	Low relief: till, rock cliffs (2-10 m)	Narrow, or spits and barriers: mixed sand-gravel beaches	Sheltered 50 km ice-free 7-8 months	1 m	Scarce, but locally abundant

Further subdivision of the Eastern Shore has been attempted (Munroe). Among other units he identifies such distinctive areas as the large salt marshes of Lobster Bay (unit 831). In Lobster Bay the drowned drumlins and the rock outcrops are aligned parallel with the axis of the bay, forming large shallow estuaries where the large tides penetrate the very gently sloping valleys of rivers such as the Tusket, Annis, Chebogue and Argyle. Another distinctive unit is the Baymouth-Barrier beach system east of Halifax Harbour to Owl's Head (west of Ship Harbour (unit 833)). Drumlins in this area provide abundant sediments for beach formation.

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T23 Oceanic Environments, T24 Modifying Forces

REFERENCES

See T28 Offshore Bottom Characteristics

T28 Offshore Bottom Characteristics

Glacial events are the dominant explanation for the distribution of sands and gravels, silts and clays and glacial tills which are presently submerged. Changing sea level in the post-glacial period has caused the glacial till, which is deposited to the outer edge of the continental shelf, to be reworked in the surf zone as the sea advanced over the land. The lowest post-glacial level of the sea, about 380-400 feet (115-120m) below present sea level, is an important boundary in explaining the distribution of submarine deposits.

ATLANTIC COAST

Two major physiographic divisions are found on the continental shelf, the Scotian Shelf and Laurentian Channel. Sands and gravels associated with lower sea levels are entirely confined to the higher elevations of the banks. The much lower levels of the Laurentian Channel, 1,400 feet (420m) or deeper, are blanketed with silty clay and silt which obscure the underlying glacial till. However silts and clays are also found in the depressions of the central shelf which parallel the Atlantic Coast and the Bay of Fundy.

L.H. King, in a series of reports dealing with submarine surficial geology, has provided a simple explanation for the complex sequence of deposits mapped off the Atlantic Coast.

In the late Pleistocene, sea level was much lower than at present, leaving the inner shelf (a seaward continuation of the southern uplands) and the outer banks as predominantly dry land. At some time glacial ice extended across the outer banks to the southern edge of the continental shelf leaving glacial till, sometimes of great depths, 500 feet (150 m) in depressions, throughout the area. The till was deposited as a submarine deposit in the basins while some, in places, were almost cut-off from the open sea. A moraine extends almost continuously from the Laurentian Channel to the Gulf of Maine, about 15-20 miles (25-30 km) off the coast and parallel to it, Figure 23. It is not known whether this moraine represents a readvance of glacial ice or is a stationary phase in the overall retreat of ice from the shelf. At the time of its formation the outer shelf was probably a series of large ice-free islands. Stylized sections of these deposits, derived from King's work, are shown in Figure 47. A summary of depositional characteristics is given in Table 5.

i) Deposits associated with maximum exposure of the continental shelf

As sea level remained depressed for some time, an erosional terrace was cut by the sea in the glacial till. This terrace has been identified throughout the shelf at depths of 380-400 feet (115-120 m). Below the terrace wave disturbance has removed fine deposits from the till, leaving well sorted sands and gravels such as are found in the littoral zone today. These deposits are known as the Sambro sand. They are restricted to a band only a few miles in width where the terrain is steep as on the fringes of the Banquereau and Sable Island Banks. Off Halifax and to the west the lower sea level coincided with flatter terrain so that the reworked till deposits cover a very wide area, especially east of LaHave Bank and west of Yarmouth. The sand is usually only a thin veneer over glacial till, which occasionally thickens to 65 feet (20 m), and is characterized by 5-10 percent of mud still remaining in the deposit. In places the Sambro sand is found at higher elevations than the former shoreline. This is assumed to indicate the presence of glacial ice on the shelf as sea level rose. These deposits are found on the inner shelf south of Cape Breton Island. In the Bay of Fundy the land surface has risen, following the retreat of glacial ice, so that the terrace is now less deeply submerged than further east. Sambro sands and gravels are found at 400 feet (120 m) (and deeper) north of Browns Bank but at only 125 feet (37 m) (and deeper) off Brier Island. In the Bay of Fundy increased current activity in the last few thousand years has modified the glacial till. While the Sambro sand deposit is a relict over most of the Scotian shelf, in the Bay of Fundy it is being actively worked at the present time. Extensive sand waves, ripples and megaripples with heights of up to 60 feet (18 m) have been mapped in these recent Sambro sand deposits. Sand waves in the Sambro sand have also been mapped on the steep walls and bottom of the Laurentian Channel at depths of over 650 feet (200 m) and are presumed to have been formed by the action of bottom currents.

At the same time as the Sambro sand was being formed in the relatively shallow waters of the littoral zone, silt was being deposited in waters immediately adjacent to the ice sheets both from melt waters and from floating ice. This unit, named the Emerald Silt, fills many of the basins on the Scotian Shelf but is only generally exposed around the edges of the basins as the slope rises towards the banks. In deep topographic depressions silt over 650 feet (200 m) thick may be found. Usually the silt gradually merges into the Sambro sand.

The Emerald silt is usually very poorly sorted except locally where currents sorted the material; it is muddy with some organic matter (2-5 percent) and calcium carbonate, also 2-5 percent. It is similar to the underlying glacial till, as would be expected, except that the gravel and larger fragments are often absent.

ii) Deposits formed during the post-glacial marine transgression

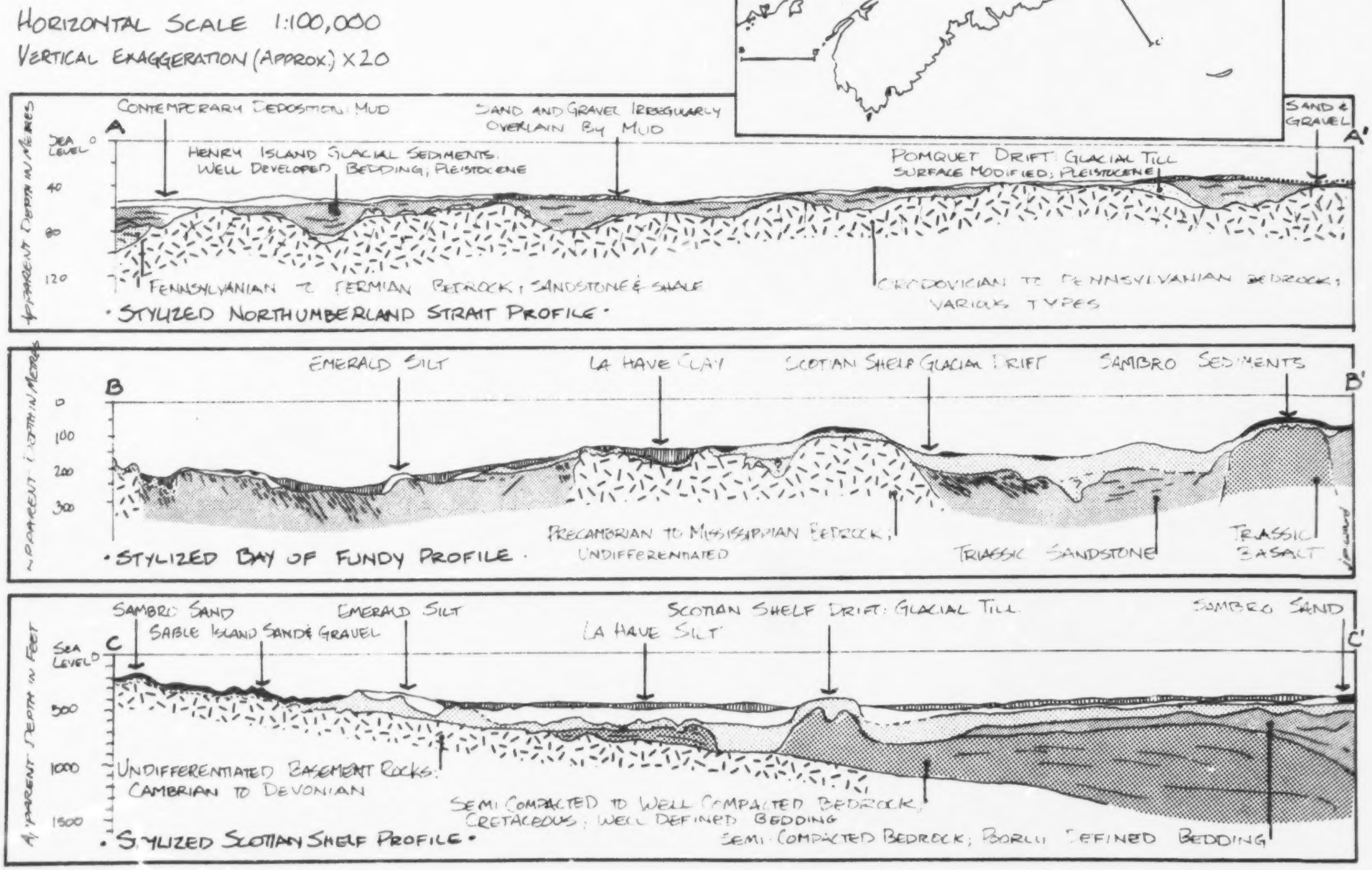
The marine transgression still continues. Sorting of materials at the coast today provides a close comparison with the processes which have been forming deposits on the formerly exposed shelf flooded by the transgressing sea. As the fairly deep glacial tills are eroded a lag deposit of boulders, cobbles and gravel is left as the sand, silts and clays are removed. While sand and gravel is transported within the littoral zone, the silts and clays are removed to be redeposited in deeper basins off-shore.

Lag deposits, sands and gravels deposited by the transgressing sea are known as Sable Island sand and gravel. These deposits cover enormous areas on the banks which lie above the former lower sea level marked by the 400 feet (120 m) submarine terrace. All the banks were exposed. Sable Island Bank, Banquereau Bank, eastern Emerald Bank, Middle Bank and the outer areas of Browns Bank are predominantly sand covered, while the other banks are predominantly gravel covered. The seaward extension of the Southern Uplands is dominated by lag deposits, with great irregularity in the sediment size. The tops of many of the banks are also covered with lag deposits.

The sands and gravels of this deposit are clean, very well sorted and dominated by quartz, 80-90 percent, which in other deposits is usually 55-65 percent. Organic matter is also low. All this evidence tends to confirm the extensive reworking and transportation which took place at the coast as the coast line moved inland towards its present location. In some shallow areas this reworking still continues. The long former coastline of the outer banks, especially Sable Island Bank and Banquereau Bank, must have allowed long-shore drift of sand to move substantial volumes of sand over great distances, although the mineralogical composition of the sands on the two banks suggests distinct sources.

Silt and clay winnowed from the glacial deposits by the transgressing sea has been deposited in the deeper basins over the Emerald silt and glacial till and is termed the LaHave clay. In the Gulf of Maine sand-sized particles, which constitute 20 percent of the deposit in Crowell Basin, are as much as 60 percent foraminiferal tests. Other organic debris is common in the LaHave clay, which is probably still being slowly deposited. Organic matter may form up to 5 percent of the deposit which is homogenous and consists of 50-60 percent

Fig. 47. Offshore Bottom Deposits; Northumberland Strait, Bay of Fundy and Scotian Shelf. from Kranack, K. (1977)
Fader et al (1977)
King, L.H. (1970)


HORIZONTAL SCALE 1:100,000
VERTICAL EXAGGERATION (APPROX) X20
INDEX MAP
CONTEMPORARY DEPOSITION: MUD
SAND AND GRAVEL IRREGULARLY OVERLAIN BY MUD
SAND & GRAVEL
A
A'
SEA LEVEL 0
40
80
120
APPARENT DEPTH IN METRES
HENRY ISLAND GLACIAL SEDIMENTS. WELL DEVELOPED BEDDING; PLEISTOCENE
POMQUET DRIFT: GLACIAL TILL SURFACE MODIFIED; PLEISTOCENE
PENNSYLVANIAN TO PERMIAN BEDROCK; SANDSTONE & SHALE
ORDOVICIAN TO PENNSYLVANIAN BEDROCK; VARIOUS TYPES
• STYLIZED NORTHUMBERLAND STRAIT PROFILE •
EMERALD SILT
LA HAVE CLAY
SCOTIAN SHELF GLACIAL DRIFT
SAMBRO SEDIMENTS
B
B'
0
100
200
300
APPARENT DEPTH IN METRES
PRECAMBRIAN TO MISSISSIPPIAN BEDROCK; UNDIFFERENTIATED
TRIASSIC SANDSTONE
TRIASSIC BASALT
• STYLIZED BAY OF FUNDY PROFILE •
SAMBRO SAND
SABLE ISLAND SAND & GRAVEL
EMERALD SILT
LA HAVE SILT
SCOTIAN SHELF DRIFT: GLACIAL TILL
SAMBRO SAND
C
C'
SEA LEVEL 0
500
1000
1500
APPARENT DEPTH IN FEET
UNDIFFERENTIATED BASEMENT ROCKS; CAMBRIAN TO DEVONIAN
SEMI COMPACTED TO WELL COMPACTED BEDROCK; CRETACEOUS; WELL DEFINED BEDDING
SEMI COMPACTED BEDROCK; POORLY DEFINED BEDDING
• STYLIZED SCOTIAN SHELF PROFILE •

silicates and 20-30 percent quartz. The surface is remarkably smooth. The LaHave clay nowhere achieves the great thickness of the Emerald silt, although it is exposed over a much greater area of the ocean floor.

A finer, related deposit covers much of the floor of the Laurentian Channel. The Laurentian silt is at greater depths and achieves a greater thickness than the LaHave clay. It is not known to be underlain by the Emerald silt in the Laurentian Channel.

(iii) Glacial Deposits:

Although glacial till, and other fluvio-glacial deposits, are known to be deposited over the entire Scotian Shelf they are not widely exposed. In the Basins the tills are obscured by the Emerald silt and the more recent LaHave clay. Above the marine terrace of 400 feet (120 m) the tills have been extensively reworked by the transgressing sea. Below this terrace, to variable depths, wave and current action in the littoral zone also reworked the tills but not to the same extent. Undisturbed tills are therefore only exposed on the sloping sides of the basins above the silts and clays and below the reworked sands and gravels. Till outcrops are more common in the approaches to the Bay of Fundy where the sea floor has been elevated by post glacial adjustment. Deposits of glacial till in excess of 500 feet (150 m) thick have been recorded.

NORTHUMBERLAND STRAIT

Even the lowest parts of the seabed in the Northumberland Strait were exposed in late glacial times. In the early post-glacial period the transgressing sea formed an estuary between Cape Breton Island and Prince Edward Island. This estuary has continually deepened and enlarged throughout the post-glacial period. West of Cape Tormentine, New Brunswick, a more complex history, similar to that of the Bay of Fundy, occurred. Due to depression of the land surface by glacial ice the post-glacial sea was higher than at present, but subsequent rapid adjustment caused emergence of the land. More recently the sea has advanced over the land at a rate similar to that of other parts of the Maritime Provinces. This complex post-glacial history is clearly reflected in the bottom sediments.

Kate Kranck (1971), has described the bottom sediments. As on the Scotian Shelf three broad types of deposit are found: 1. glacial deposits, 2. relict deposits of gravel, sand, silt and clay, 3. a series of deposits still actively being worked. The second and third of these groups are known collectively as the "Goldthwait Sea sediments" and the "Northumberland Strait sediments". Compare deposits of the Atlantic Coast and the southern Gulf of St. Lawrence using Figure 47 and Tables 4 and 5.

(i) Goldthwait Sea Sediments:

Buctouche sand and gravel is a lag deposit formed as the transgressing sea winnows out the silt and clay size particles of the glacial till. Where stronger currents occurred a very clean well-rounded gravel deposit is formed with the sand concentrated in deeper water areas. In shallow areas or other areas with strong tidal currents, reworking of sediments is continuing. It is therefore sometimes difficult to distinguish relict sand and gravels from contemporary deposits.

Malagash mud, an estuarine quiet water deposit, is limited to the narrow sound between Wood Island, P.E.I. and Caribou Island. The mud is being actively eroded at present and probably extended over a much larger area in the recent past. Erosion of the mud would probably have started when the estuarine depositional environment was destroyed by the flooding of the isthmus which joined Cape Tormentine (N.B.) to Prince Edward Island, about 5,000 years ago.

(ii) Northumberland Strait Sediments

Contemporary deposits, closely allied to the Goldthwait Sea sediments, occur at the surface throughout much of the Strait. On the Scotian Shelf those two types of deposit have not been differentiated, as the continuing contribution of silts and clays is much less significant than in Northumberland Strait.

Contemporary sand deposits on the shallower banks and in the Bay of Fundy could be correlated with contemporary sand and gravel deposits mapped in Northumberland Strait, which are probably less significant.

Egmont sand occurs as scattered small sand bodies, containing abundant shells and characterized by mobile sand waves. None of these deposits are found immediately off Nova Scotia. The largest is off East Point, P.E.I. on a terrace cut by the transgressing sea.

Pugwash mud covers the sea bottom east from Pictou Island and between Cape John and Baie Verte. It is seldom very thick, but forms a horizontal, smooth-surfaced blanket deposit over all relict deposits, except the eroding Malagash mud. The Pugwash mud is accumulating in areas with slow currents (less than 0.5 knots), although a transitional deposit of muddy sand is found in areas with faster currents. Sources of this sediment are primarily eroding shore cliffs. Rivers only carry limited amounts of sediment which are mainly trapped in estuaries.

In parts of St. George's Bay and off the west coast of Cape Breton Island the underlying rocks are more resistant forming a more irregular sea bottom. Pugwash mud has not yet accumulated in sufficient quantities to cover these irregularities, leading to great variation in the bottom sediments.

(iii) Glacial Deposits

Pomquet Drift (glacial till) and Henry Island sediments (stratified, fluvio-glacial deposits) are exposed only off Caribou Island. The drift has filled many of the pre-glacial river valleys with till in excess of 40 m in depth. In the Strait almost all the glacial till has been removed by the rising sea level except in the deeper channels. Between Cape Breton Island and Prince Edward Island the glacial till is thin and is obscured by much thicker deposits of the stratified Henry Island sediments. Little is known of this deposit except that it is very thick, in places more than 325 feet (100 m), and stratified. It must be proglacial (formed at the same time as glacial ice) because marine terraces are cut into its submerged surface. The sediments are probably melt-water sediments deposited in a glacial lake or in sub-glacial drainage channels.

ASSOCIATED TOPICS

T9 Offshore Geology and Resources, T13 Glaciation, T15 Post-glacial Climatic Change, T25 Sea Level Change

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King (1970)
Knight (1980)
Kranck (1971)
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MacLean and King (1971)
Owens and Bowen (1977)
Piper (1980)
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Scott (1980)
Scott and Medioli (1980)

Table 4. EQUIVALENT OFF-SHORE BOTTOM DEPOSITS ATLANTIC COAST AND NORTHUMBERLAND STRAIT

Atlantic Coast (King)	Northumberland Strait (Kranck)	
1. Deposits Associated with Marine Transgression (15,000 B.P. to present)		
	Northumberland Strait Sediments (contemporary)	
Sable Island sand and gravel	Egmont sand	mobile sand bodies
LaHave clay (Laurentian silt)	Pugwash mud	contemporary, widespread veneer of silt and clay
	Goldthwait Sea Sediments (relict)	
	Buctouche sand and gravel	lag deposit formed as coastline moved inland.
	Malagash mud	estuarine mud
2. Marine Deposits Formed Below Lowest Sea Level (before 15,000 B.P.)		
Sambro sand	no equivalents	entire sea bottom exposed during glaciation
Emerald silt		
3. Terrestrial and Submarine Deposits of Glacial Till (before 15,000 B.P.)		
Scotian Shelf Drift undifferentiated glacial deposits	Pomquet Drift - glacial till	
	Henry Island Sediments - stratified lake sediments or outwash material.	

It should be emphasised that, although similar, the deposits associated with the marine transgression are not identical.

Table 5. Characteristics: Off-shore Bottom Deposits

ATLANTIC COAST			NORTHUMBERLAND STRAIT		
Deposit	median size (mm)		Deposit	median size (mm)	
Sable Island sand and gravel	sand phase gravel phase	well sorted	Egmont sand	0.3	well sorted
			Pugwash mud	0.01 - 0.12	
LaHave clay	0.06 - 0.003	contains many foraminifera	Buctouche sand and gravel	0.3	well sorted
			Malagash mud	sandy mud	poorly sorted
Sambro sand	0.6 - 0.06	contains 10% silt and clay			
Emerald silt	0.05 - 0.01				
Scotian Shelf Drift	undifferentiated		Pomquet drift	glacial till, undifferentiated	
			Henry Island sediment	stratified proglacial sediments, off Cape Breton Island	

SURFACE WATERS

T29 General Hydrology

Nova Scotia has no shortage of fresh water. The total annual precipitation is fairly high - approximately 52 inches (1,300 mm), compared to 32-38 inches (800-950 mm) in central Ontario, or 12-16 inches (300-400 mm) in southern Saskatchewan. Frequent coastal fogs, cloudy days and cool summer temperatures combine to keep evapotranspiration moderate. Large areas of impermeable rock and thin soils, and the effects of glaciation have resulted in a multitude of bogs and small lakes and in a dense network of small streams.

Water Coverage Approximately four percent of Nova Scotia's total land surface is covered by freshwater. The corresponding figure for New Brunswick is only two percent, while Prince Edward Island has very little surface water. The water coverage is not, however, evenly distributed throughout the province. Figure 48 shows the percentage of the drainage area covered by lakes and swamps for selected watersheds. In general surface water is much more abundant on the granites and quartzites of the Atlantic Interior than on the more permeable sedimentary formations. Freshwater coverage is most extensive in southwestern Nova Scotia. In some watersheds the area has been substantially

Table 6. Land and natural lake areas of the Atlantic Provinces, in ,000s square miles (km)

Province	Land	Lakes	Percentage of Freshwater area
Nova Scotia	20 (53)	1.0 (2.7)	5.1
New Brunswick	28 (72)	0.5 (1.3)	1.8
P.E.I.	2 (6)	-	0.0
Newfoundland	41 (107)	2.2 (5.7)	5.3
Labrador	101 (264)	10.9 (28.3)	10.7

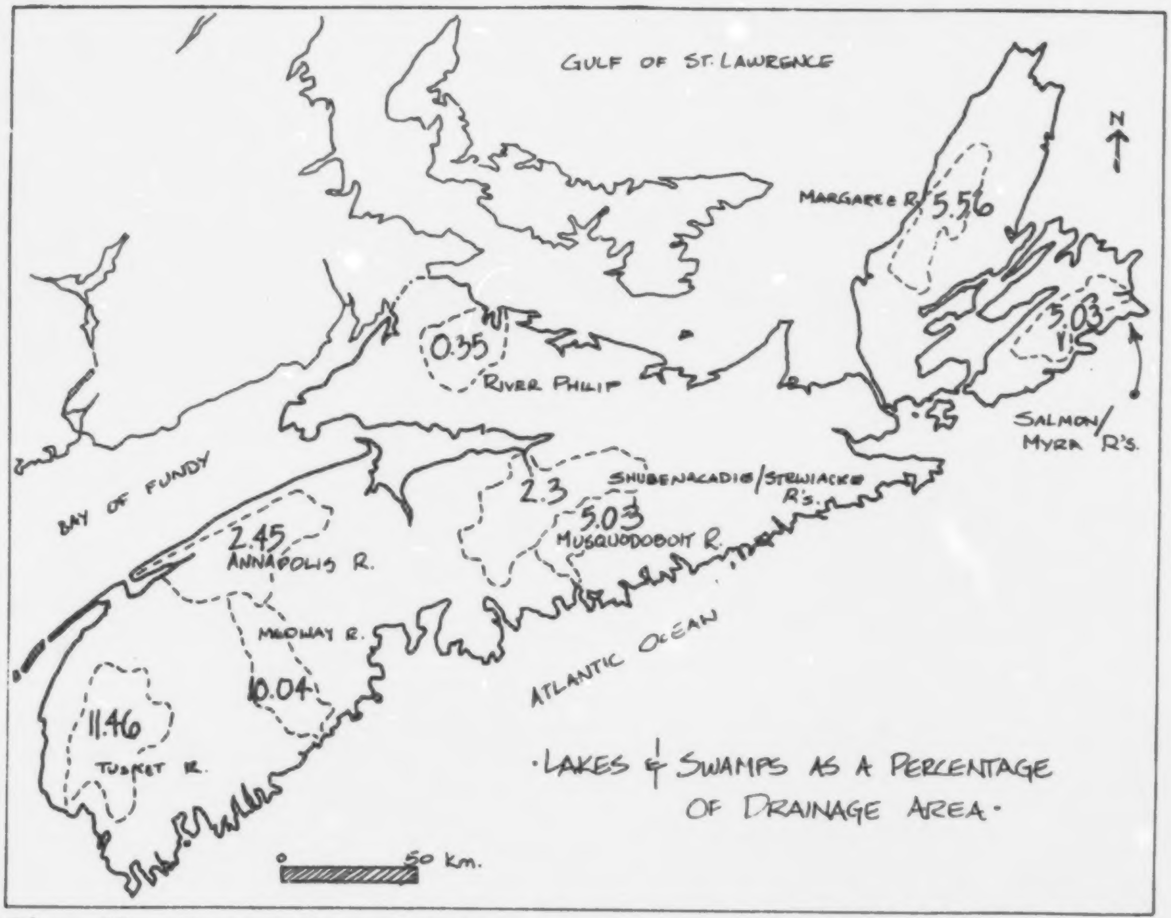

GULF OF ST. LAWRENCE
N
MARGAREE R. 5.56
5.03
SALMON/MYRA R's.
0.35
RIVER PHILIP
BAY OF FUNDY
SHUBENACADIE/STEWIACKE R's.
2.3
5.03
MUSQUODOBOIT R.
2.45
ANNAPOLIS R.
MEDWAY R.
10.04
11.46
TUSKET R.
ATLANTIC OCEAN
·LAKES & SWAMPS AS A PERCENTAGE OF DRAINAGE AREA·
0
50 Km.

Fig. 48. Proportion of Lakes and Swamps in Selected River Basins.

increased by the construction of dams. In this area coverage ranges from 10-17 percent of the total drainage basin. By contrast in areas of sedimentary rock coverage by lakes and swamps ranges between 0-4 percent.

Drainage areas

Because of the size and insular nature of the province most drainage basins are comparatively small, particularly around the coastal fringe where small streams flow directly into the sea. The major drainage divide runs east-west across the mainland. A second divide is formed by the height of land running across the top of the Cobequid Hills and the Pictou/Antigonish Highlands (district 310). Some of the larger drainage basins are found on the Atlantic Interior, such as the Mersey, 750 square miles (1,960 km^2), the La Have 590 square miles (1,530 km^2), and the Medway 575 square miles (1,490 km^2). The largest drainage basin in the province belongs to the Shubenacadie-Stewiacke river system which drains an area of approximately 1,075 square miles (2,800 km^2) in central Nova Scotia.

In Cape Breton the fragmented topography and the existence of the Bras d'Or Lake system (district 560) in the middle of the island keeps most drainage basins relatively small with the exception of the Margaree river system 450 square miles (1,170 km^2)

Water Budget

The mean total annual precipitation is 52 inches (1,300 mm), which is spread fairly evenly throughout the year. The mean annual run-off is estimated to be 37.5 inches (940 mm). Run-off is influenced by many factors including soil type, soil moisture conditions, slope, and forest cover. In general, coarse soils with low to moderate run-off potential occur across the province, but the more finely textured soils with somewhat higher run-off potential are more commonly found in the central and northern areas of the province.

Accurate measurements of evapotranspiration are not available but a rough approximation suggests that it accounts for 8-16 inches (200-400 mm) a year. This indicates that little water is absorbed by deep storage. This is particularly true in areas of igneous and metamorphic rock. The only significant aquifers are found in sand and gravel deposits, for example in the Annapolis and Margaree

Valleys, and in sandstone and gypsum areas, throughout regions 500 and 600 as for example Colchester and Cumberland Counties and parts of Cape Breton. Figure 49 shows the mean annual run-off pattern for the province, indicating a general increase from north to south on the mainland and somewhat higher values in Cape Breton.

Discharge Patterns

Precipitation is highest in the late fall and winter months, and generally lowest in June and July, beginning to rise again in August with the arrival of the late-summer storms tracking up from the Caribbean region. Characteristically, stream discharge peaks in March and April as a result of snowmelt, and then drops quite dramatically, being lowest in June, July and August. Figure 50 shows the annual run-off pattern in hydrographs for the whole province and for seven individual rivers.

Water flow in the streams that drain the thin soils overlying igneous rock formations is maintained largely by surface run-off. In these streams levels tend to drop and temperatures rise in summer. Many of the smaller streams will dry up. By contrast there are fewer streams draining the deeper soils of sedimentary areas, but springs and spring seepage tend to ensure a more constant flow of relatively cool water throughout the year.

Lakes and Ponds

Lakes and ponds are the result of an interruption of drainage, either by the formation of a basin or by a barrier blocking the flow of water. There are approximately 10,600 lakes in the province, of which 6,700 - or almost two thirds - are under 25 acres (10 ha) in area. The main lake district is found on the granites, quarzites and slates of the Atlantic Interior and particularly in southwest Nova Scotia. Few lakes are found in sedimentary areas, although backwater ponds often develop in slow-flowing streams and rivers. The majority of lakes are of glacial origin, and are generally aligned with the direction of the ice movement. Very few lakes are geologically controlled, one example being the lakes formed between the beds of basalt on Digby Neck (district 810). Lakes may be categorized by their origin as follows:

Glacial lakes	formed either as a basin scoured out by ice

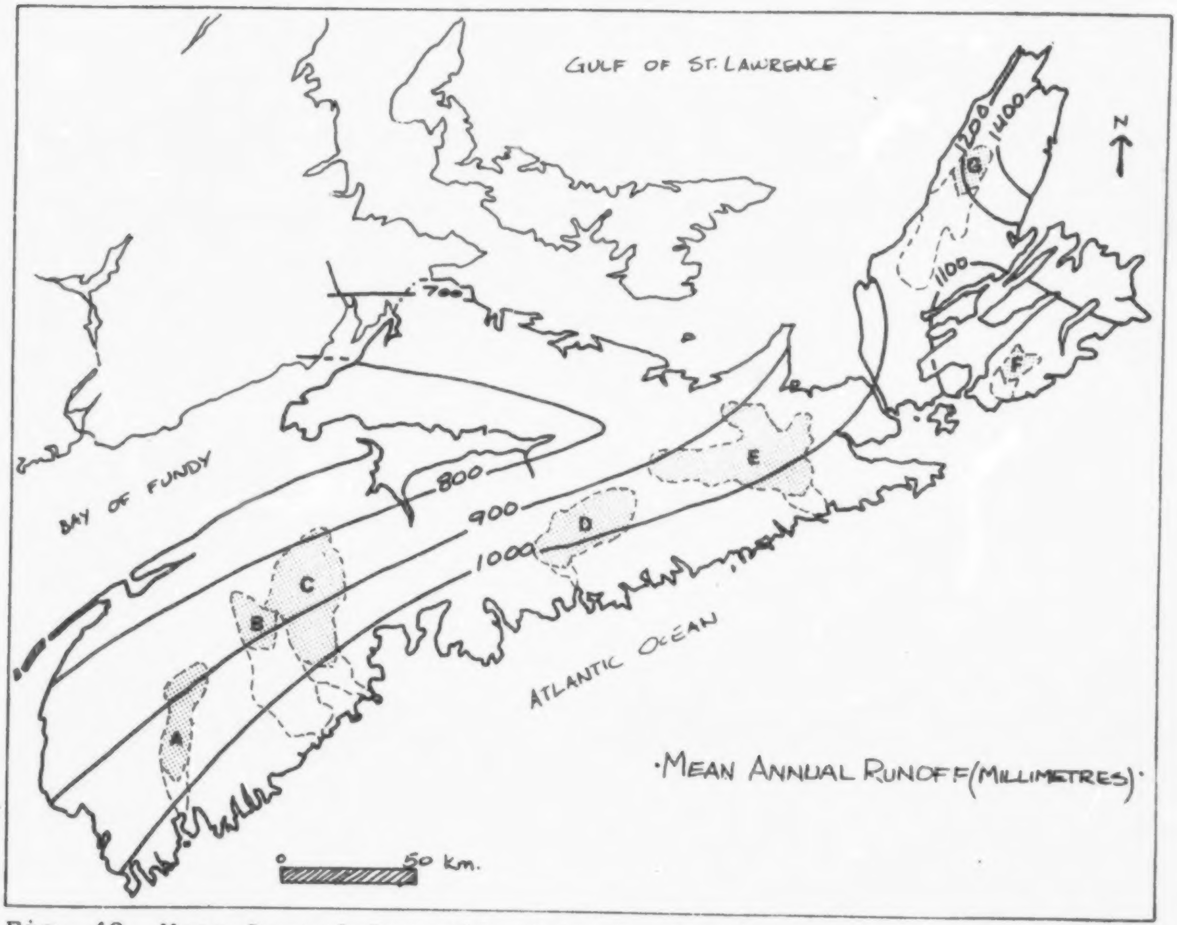

GULF OF ST. LAWRENCE
BAY OF FUNDY
ATLANTIC OCEAN
700
800
900
1000
1100
1200
1400
A
B
C
D
E
F
G
N
0
50 km.
·MEAN ANNUAL RUNOFF (MILLIMETRES)·

Fig. 49. Mean Annual Run-off, Nova Scotia (hydrographs of stations indicated are shown in Fig. 50).
MacLaren Atlantic (1980)

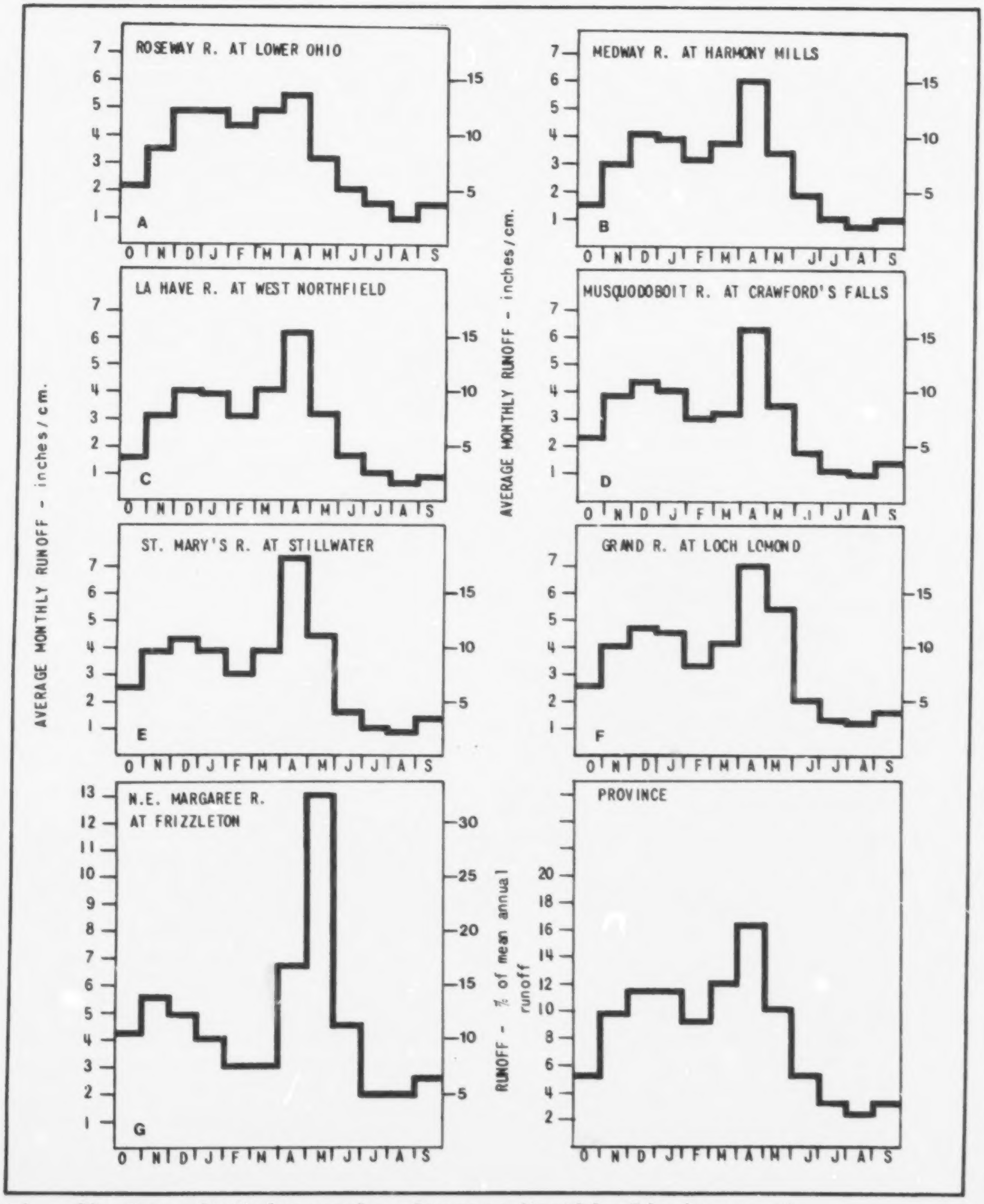


Fig. 50. Run-off Hydrographs; Average Monthly Discharge of Selected Drainage Basins. (for locations see Fig. 49). Montreal Engineering (1969)

	movement or by the interruption of the original drainage by the deposition of glacial till.
Oxbow lakes	formed when river meanders are cut off from the main channel, good examples being found in the Stewiacke Valley.
Man-made lakes	often created to regulate water flow for lumbering, flood control or power generating purposes, and typically filled with rotting forest debris. These also include impoundments for waterfowl conservation.
Gypsum sink-holes	these occur particularly in the Windsor and Margaree areas, are less acid and have higher salt content.
Barrier or barachois lakes	typically these have higher salinity and many are brackish, either because of some tidal flow or through salt spray. The most extensive examples are found between Cape Gabarus and Fourchu Harbour in Cape Breton.
Beaver ponds	these are usually permanent because the Beaver use them on a regular basis.

Thermal stratification, a characteristic of large lakes, does not occur in the majority of Nova Scotia's small, shallow lakes. In larger lakes wind becomes a more important factor, driving water circulation and exposing parts of the shoreline to wave action. If the lake is sufficiently deep stratification will occur but the consequent diminution of oxygen in the lower layers seldom takes place because most lakes are unproductive. Table 7 lists some of the larger lakes in Nova Scotia.

Table 7. Some Large Lakes in Nova Scotia

Lake	Surface area, Square miles	(km^2)
Bras d'Or (salt water)	425	1100
Rossignol*	64.5	168
Ainslie	21.5	56
Mira River	12.3	32
Kejimkujik	8.9	23
Gaspereau*	8.5	22
Grand	6.9	18
Panuke	5.8	15
Pockwock*	3.1	8
Sherbrooke	2.3	6

*enlarged by impoundments

Ice cover on lakes affects light penetration and the availability of oxygen in the productive lakes. Throughout most of Nova Scotia the mean daily temperature is below freezing for at least 100 days during the year. The actual formation of ice will depend on the size and depth of a lake and its exposure. Only limited records on ice cover have been collected. Table 8 shows the mean dates for ice formation and break-up for four lakes or rivers in Nova Scotia.

Table 8. Mean Dates for Formation and Break-up of Ice Cover

Lake/River	First Permanent Ice	Complete Freeze-over	First Deterioration of Ice	Water Clear of Ice
Goshen Lake (Guysborough Co.) (district 570)	Dec. 22	Dec. 25	Apr. 09	Apr. 23
Grand Lake (Near Sydney) (district 550)	Dec. 23	Dec. 25	Apr. 14	Apr. 19
Ecum Secum River (Hfx. Co.) (unit 834)	Dec. 09	Dec. 16	Mar. 28	Apr. 01
Salmon River (Truro) (unit 602)	Dec. 16	N/A	Mar. 09	Mar. 28

Data based on varying numbers of observations between 1940-1974.

Wetlands

Wetlands play an important limnological role in Nova Scotia in terms both of regulating water flow and of influencing water quality. Acting like sponges, wetlands help to even out the peaks in stream flow, particularly in areas where flow rates respond very quickly to precipitation. Wetlands also act as recharge areas for the underground water table.

Wetlands can affect water chemistry in a number of ways. Highly productive marshes may export nutrients and organic material to the rest of the drainage system. At the other end of the productivity scale, sphagnum bogs acidify water, and may add humic dyes, increasing colour and lowering light penetration.

The character of a wetland is in large part determined by the type of soil, mineral or organic, which accumulates; the degree of inundation; and the source of the water supply that feeds it. The more productive marshes or wooded swamps (floodplain forest communities), which are comparatively uncommon in the province, are based on alluvial silts, while bogs and shrub swamps are based on organic peats.

Peatlands

Peatlands can be classified according to their water supply. Rheotrophic wetlands (literally "fed by flow") receive water both from rain and from surface or groundwater flow. Ombrotrophic wetlands ("fed by rain") are dependent on precipitation. On this basis three types of peatland have been identified in Cape Breton. The reader should be warned that such terms as bog, swamp, and fen may be used differently in various classification systems.

Fens: These receive water from four sources: direct precipitation falling on the surface of the fen; precipitation that falls within the catchment area and is influenced by the soils and vegetation; ground water where the depression intersects the water table; and water which comes from beyond the immediate catchment area. Because of the variety of factors affecting water chemistry fens will generally receive a better supply of nutrients, although the insoluble nature of the bedrock in most areas of Nova Scotia means that concentrations of bicarbonate and calcium are rarely high.

Bogs: Used in this specific sense the term denotes a wetland that is raised above and therefore cut off from the surrounding catchment area. A bog is dependent on direct precipitation for ionic input, and is therefore nutrient poor.

Transition bogs: These exhibit hydrological characteristics intermediate between fens and bogs. The water supply comes from two sources - direct precipitation, and the immediate catchment area.

Wetland Inventory

A wetlands inventory is presently being carried out as a joint project by the N.S. Department of Lands and Forests and the Canadian Wildlife Service. When finished it will provide valuable information on the classification, size, distribution, and wildlife value of wetlands in Nova Scotia. The inventory recognizes eight categories of freshwater wetland based on dominant vegetation, and listed here in order of abundance in the province.

Bog	acid peatland formed from deep accumulations of Sphagnum moss
Shrub-swamp	permantly flooded areas with shrub stands
Meadows	seasonally flooded area supporting sedges and grasses
Wooded swamp	primarily floodplains, seasonally flooded up to 3 feet (1 m) deep
Seasonally flooded flats	flooded more than 5 inches (12 cm), herbaceous cover which may also include cattails, shrubs or trees
Open water	
Deep marsh -	water from 8 inches to 3 feet (0.2 to 1.0 m) deep with rooted aquatic plants.
Shallow marsh	water less than 8 inches (0.2 m), with cattails, sedges, weeds and other emergent plants.

REFERENCES

See T30 Water Quality

T30 Water Quality

General factors

Water quality depends on the interaction of many factors. These include bedrock composition, watershed size, response to precipitation, topography, vegetation and proximity to the sea. Limnological information for Nova Scotia is as yet scattered, but very general limnological regions have been delineated on the basis of geology and soils (see Figure 51). In areas of resistant igneous and metamorphic rocks, where most lakes are found, waters are usually very low in dissolved solids. Somewhat higher salinities appear to characterize the surface waters which drain areas of lime-deficient Carboniferous sandstones and shales in Cumberland County. Comparatively high salinities are found in areas where the sedimentary rocks are a good source of lime. The amounts of calcium and magnesium strongly influence the buffering capacity and hence moderate the acidity of the water. The ratio of watershed area to lake size affects nutrient availability and the flushing rate. In natural conditions, water bodies with low water renewal rates generally have lower concentrations of total phosphorous - an important nutrient for plant growth. This is because the source of supply comes from a limited drainage area. If, however, the supply of phosphorous to these same lakes is somehow increased, as for example from the impacts of development, the low flushing rate may result in increased nutrient enrichment, and accelerated "aging".

The response rate of streamflow to precipitation controls the interaction between water and soils and bedrock, thus influencing chemical composition. Topography influences the collection of mineral sediments and the accumulation of peat deposits in and around lakes.

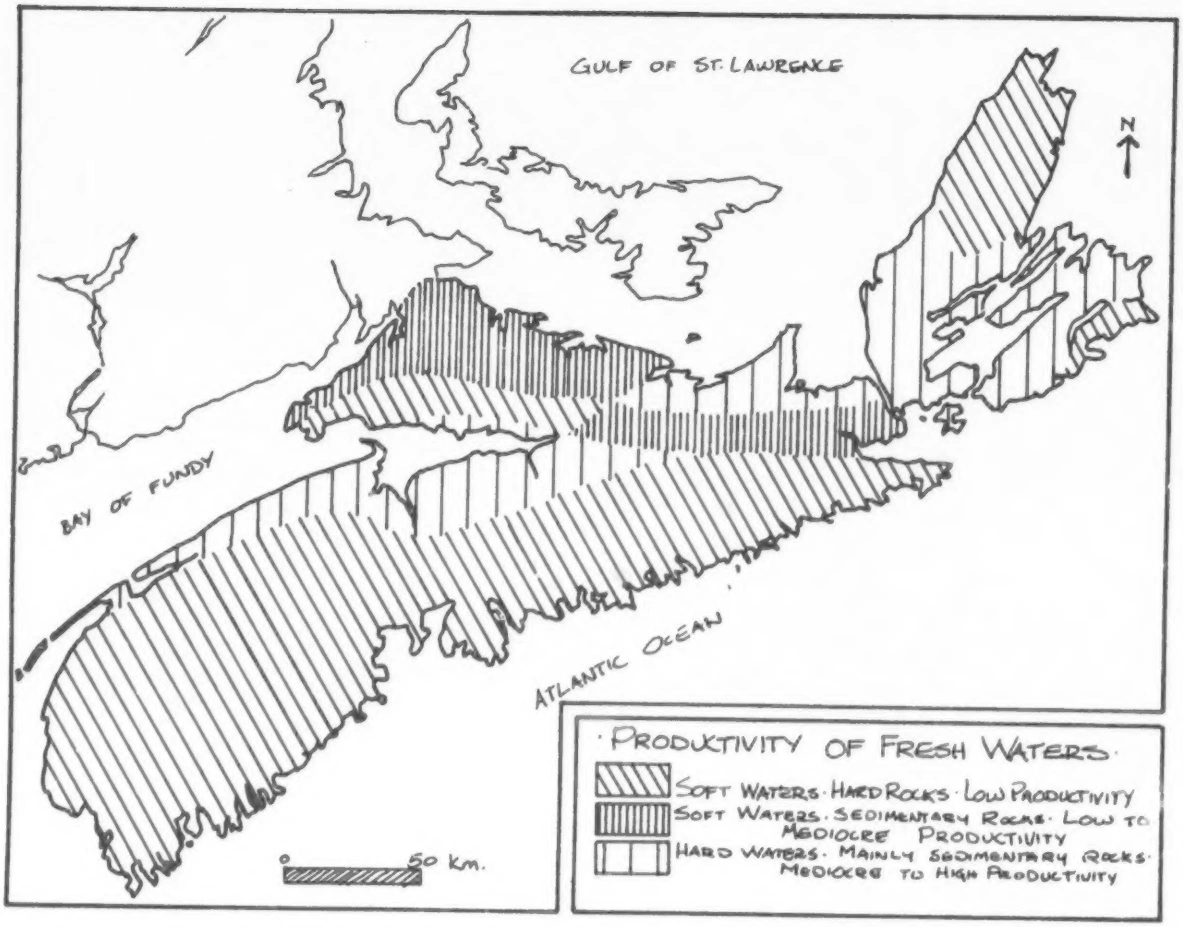

GULF OF ST. LAWRENCE
N
BAY OF FUNDY
ATLANTIC OCEAN
0
50 km.
PRODUCTIVITY OF FRESH WATERS
SOFT WATERS · HARD ROCKS · LOW PRODUCTIVITY
SOFT WATERS · SEDIMENTARY ROCKS · LOW TO MEDIOCRE PRODUCTIVITY
HARD WATERS · MAINLY SEDIMENTARY ROCKS · MEDIOCRE TO HIGH PRODUCTIVITY

Fig. 51. Productivity of Surface, Fresh Waters, Nova Scotia. Smith, M.W. (1963)

Where the vegetation is predominantly coniferous, the needles - which are very resistant to decomposition - contribute few primary nutrients, but do add organic acids. Deciduous litter releases nutrients more readily. The leaves are an important food source for aquatic animals. Proximity to the sea will often result in high chloride concentrations from sea spray carried in precipitation.

Productivity

In areas of igneous and metamorphic rock, where most lakes are found, the water has low electrolyte levels and lakes are generally oligotrophic. Where the drainage system includes many bogs and peat deposits waters are frequently dystrophic - strongly coloured and with high organic content. Standing crops of bottom fauna have usually been found at less than 0.003 ounces/square foot (one g/m^2) without mollusc shells. Standing crops of fish, usually mixed populations, varied from 17 to 36 lbs/acre (19 to 40 kg/ha) in six lakes treated with fish poisons. Yields of brook trout to anglers are low, and were reported in one study to be 0.9 lbs/acre (1 kg/ha) (Alexander and Merrill, 1976).

A somewhat higher electrolyte content and moderate mesotrophy appear to characterize the waters (mainly streams) draining the areas of lime-deficient Carboniferous sandstones and shales in the Cumberland area.

Comparatively strong mineralization and high productive capacity are found in areas where sedimentary rocks are a good source of lime. In these areas agriculture is often the cause of additional nutrient enrichment.

Acidity

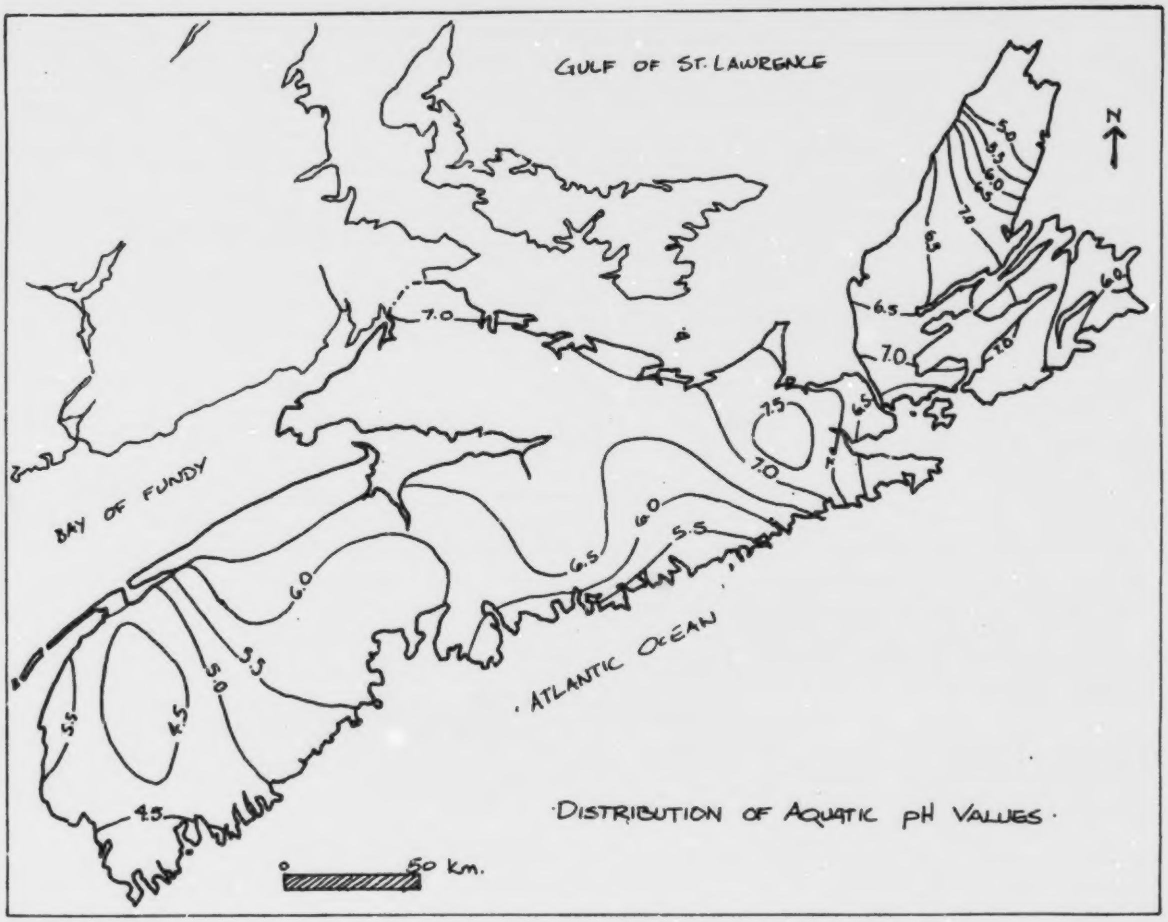
The acidity of ground and surface waters depends upon the acidity of the precipitation and the buffering capacity provided by the calcareous material and, to a lesser extent, the aluminium, iron and manganese oxides in the bedrock and soils. Low pH levels, which indicate higher acidity, affect the reproduction of aquatic biota, increase the toxicity of the water through increased metal concentrations, and tend to correlate with lower species diversity of phytoplankton and benthic invertebrates. Low pH values are often associated with bogs and brown, humic waters.

Most of the rock types in the province are very resistant and have little buffering capacity. Only Carboniferous limestones and some of the sandstones have any appreciable lime content. The podzolic soils which predominate have pH levels ranging from 5 to 6, and are similarly poorly buffered. Figure 52 shows the general distribution of aquatic pH values in the province. It will be noted that waters in southwestern Nova Scotia are particularly acid, with pH values increasing in the Carboniferous areas.

A study of 23 lakes in Halifax County (Gorham 1957) showed highest levels of sea salt as indicated by chloride and Sodium in the lakes closest to the coast. A direct relationship with distance from the sea exists for these two measures. Duncan Lake (near Duncans Cove) had chloride concentrations of 15.2 ppm in contrast to concentrations in the range of 3-6 ppm found in lakes further inland.

Seasonal Variations

The chemical composition of surface waters undergoes seasonal fluctuations as illustrated by water quality data from the St. Marys River at Stillwater plotted against the rate of flow (Figure 53). When discharge is greatest in early spring the waters are diluted. The specific conductivity, which is largely related to the concentrations of dissolved solids, is shown to be at its lowest point in April; peaking in July when discharge is lowest; dropping suddenly after what was evidently a wet August; and then climbing back up during the relatively dry months of September and October. The water is most acidic in the mid-summer months, indicating that the acids formed by the decomposition of organic materials are not being flushed away as quickly as in the winter months.


GULF OF ST. LAWRENCE
BAY OF FUNDY
ATLANTIC OCEAN
DISTRIBUTION OF AQUATIC pH VALUES
N
0
50 km.
7.0
7.5
7.0
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6.0
6.5
7.0
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6.5

Fig. 52. Flowing Fresh Waters; pH Values, Nova Scotia.
Clair et al (1981)

Water Quality Data – Stillwater 1971

SOURCE: N.S. MUSEUM, ST. MARY'S RIVER WATERSHED : WATER QUALITY ; n.d.

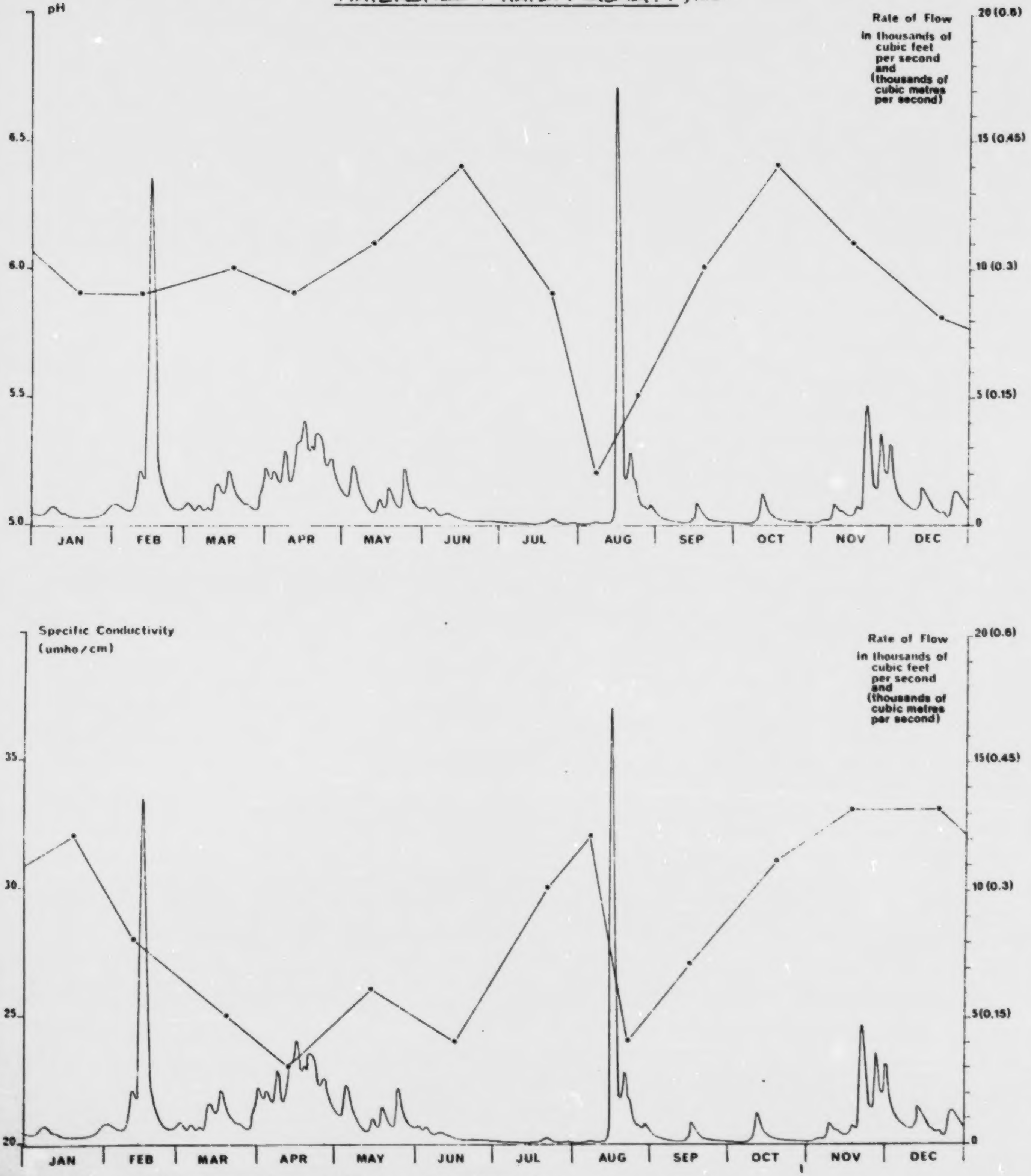

Fig. 53. Relationship of Water Quality (pH, top and dissolved solids, below) to Discharge, St. Mary's River.

ASSOCIATED TOPICS

T12 Tertiary Drainage Patterns, T51 Wetland Birds and Waterfowl, T58 Amphibians and Reptiles, T59 Land and Freshwater Inverterbrates, T61 Freshwater Fishes.

ASSOCIATED HABITATS

H10-16 Freshwater Habitats

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Hayes and Anthony (1958)
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N.S. Museum (undated) St. Mary's Watershed
Smith (1963)

SOILS

T31 Soil Development and Soil Climate

The development of different soils depends upon the interactions between the following factors: parent materials, climate, topography, living organisms, and time.

Parent materials	These determine the mineral content and, to a large extent, the texture of the soil. They influence soil fertility, internal drainage and colour. The type of mineral affects the rate at which chemical weathering takes place.
Climate	The rate of chemical weathering also depends on the availability of moisture, and on temperature. Abundant rainfall increases the downward removal of nutrients and other material by leaching. Climate strongly influences vegetation, which in turn modifies the climate at ground level. Decomposition of organic material is assisted by warm temperatures and inhibited by cool temperatures. Nova Scotia's climate is now essentially cool and humid but the development of most modern soils would also have been affected by the warmer hypsithermal period of approximately five thousand years after the last retreat of the ice sheet.
Topography	Elevation affects temperature, rainfall and drainage. Level areas collect water and soils formed on them may be heavily leached, sporadically waterlogged, or both. Slopes shed water, which may hinder chemical weathering and slow soil development. The run-off may erode surface layers. Finally, the orientation of a slope will affect the micro-climate, and consequently the vegetation.
Living organisms	The influence of vegetation and of soil microflora and fauna is closely linked with climatic factors. Plant roots bring up nutrients from deeper soil layers, eventually

depositing them on the surface through litter fall. The extent of leaching is partly governed by the type of litter, being greatest under coniferous and moss litter, less under deciduous and least under grass. Organic matter incorporated in the mineral soil develops soil structure, affecting soil aeration, root penetration, moisture storage and drainage. Organic matter also affects the activity of micro-organisms, which in turn play a vital role in breaking down organic matter and mobilizing plant nutrients. Coniferous litter decomposes slowly, creating a very acid soil environment which does not favour earthworms and arthropods. Most of Nova Scotia's soils have developed under coniferous or mixed wood forests, which - combined with other factors - has resulted in acid soils, low in nutrients and organic matter below the surface layer.

Time The maturity of a soil is usually reflected in the development of distinct layers or horizons. While most of Nova Scotia's soils have developed over the relatively short span of 10,000 years since the end of glaciation, most of the soils can be classified as fairly mature because the pedogenic or soil forming processes have been highly active. Reasons for this include the effects of glaciation breaking down the bedrock to unconsolidated material, the humid conditions, and the warm post-glacial period. Soils formed on more recent marine and alluvial deposits are "younger", and exhibit less profile development.

PARENT MATERIALS

Parent materials are the unconsolidated materials in which some physical and chemical weathering has taken place and from which soil is developed. Parent materials in Nova Scotia may be divided into five main categories:

a) glacial till - including basal and ablation tills, and drumlins
b) stratified glacio-fluvial and outwash deposits of sand and gravel
c) alluvium - stream or river deposited sediments
d) marine sediments - including recent tidal deposits and older sea bottom deposits, exposed by postglacial isostatic rebound
e) organic deposits

Glacial Till Glacial till is the most extensive surficial deposit in the province, and is usually derived from the bedrock directly beneath. Transportation of material by the ice sheet was minimal, amounting usually to no more than a mile or at most two. The depth of these glacial tills rarely exceeds 15-20 feet (5-7 m) and is more often in the range of 3-5 feet (1-2 m). The main exceptions to this rule are the tills which make up the drumlins occurring between eastern Lunenburg County and Canso. These tills, which usually contain material of Carboniferous origin, have been moved long distances. In the case of the Lunenburg drumlins, the tills may have originally come from the Bay of Fundy or further north in New Brunswick. Typical soils developed on these tills are mapped as the Wolfville series, or, in Annapolis County as the Bridgetown series.

Glacial till is usually divided into a compact bottom or basal till, with a platy type of structure, and an upper, looser, ablation till. Basal tills derived from sedimentary or metamorphic rocks generally have a larger fraction of illite and smectite (swelling clays) than is found in granitic rocks. These clay minerals, which are derived from mica, will absorb more moisture than the clay minerals in granitic rocks, improving moisture and nutrient storage. Soils developed on glacial till over hard, crystalline rocks tend to be coarse in texture, shallow and well drained. Soils developed over sedimentary rocks are somewhat finer.

Glaco-fluvial and Outwash Deposits

Soils developed on glaciofluvial deposits are often rapidly drained, extensively leached and subject to drought in the summer months. Soils on glaciolacustrine deposits usually have finer textures, and poor internal drainage.

Alluvium

Soils developed on recent stream or river deposited sediments vary from poorly to well drained, depending on the degree to which the sediments were sorted by water actions. They are often subject to intermittent flooding and erosion. The Cumberland and Stewiacke series are examples of well-drained alluvial soils, while the Bridgeville series is imperfectly drained and the Chaswood series poorly drained. Alluvial soils do not usually exhibit a highly developed profile.

Marine Deposits

Soils developed by the dyking of estuarine marshes are deep, fine-textured, imperfectly to poorly drained, and relatively nutrient rich. The soils have formed too recently to exhibit horizon development but buried layers of peat or organic rich material may be found. These soils are mainly classified as belonging to the Acadia soils complex (which has too wide a range of characteristics to be termed a soil series), but the Chegoggin series near Yarmouth has also formed on tidal deposited sediments. Here, however, the accumulation was slower than in the Bay of Fundy because of the lower tidal range. Salt tolerant vegetation was thus able to become established, resulting in a higher organic content.

SOIL CLIMATE

For general information on the climate of the province see T18-20. The soil climate is the integration of those aspects of climate which most affect root development, subaerial plant growth, soil structure and the environment of the soil microflora and fauna. The soil climate classification is based on soil moisture and soil temperature regimes during the year, which is divided into a growing season and a dormant season. The soil temperature is recorded at a depth of 20 inches (50 cm) and the growing season is defined as the period when soil temperatures exceed 42°F (5°C).

The sheltered Annapolis Valley has a Mesic temperature regime, while the rest of southern Nova Scotia falls in the range of moderately cool Boreal to mild Mesic. The northern part of the province is moderately cool Boreal, with the exception of the Northumberland Strait shore which - together with southern Cape Breton - is cool Boreal. The rest of Cape Breton is moderately cold Cryoboreal, (see Figure 54). The entire province is classified as Perhumid, meaning that the soil is moist all year with the exception of the Annapolis Valley and parts of the Central Lowlands which are Humid, and may experience very slight moisture deficits in the growing season.

REFERENCES

See T35 Hardpans

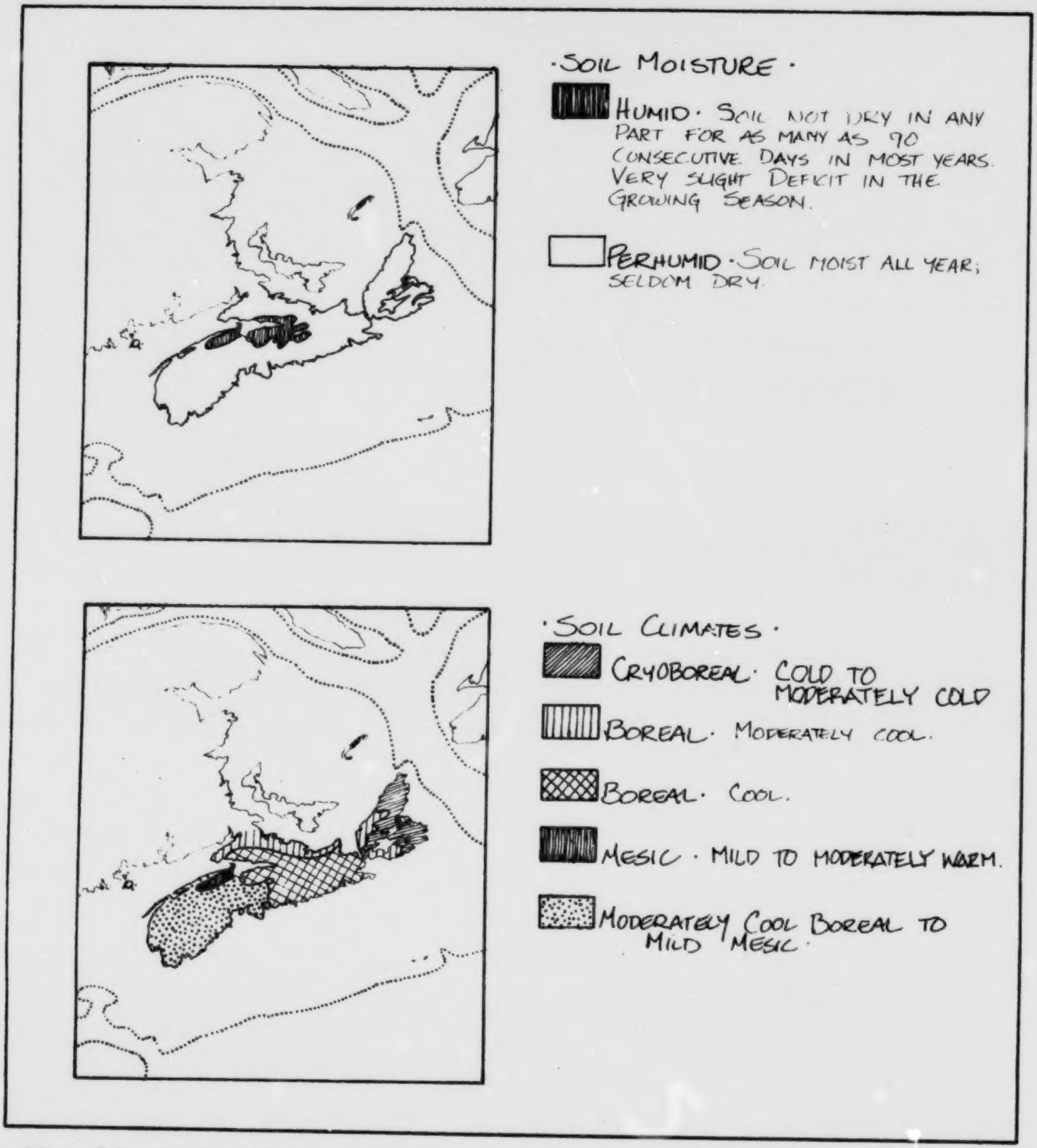

·SOIL MOISTURE·
HUMID· SOIL NOT DRY IN ANY PART FOR AS MANY AS 90 CONSECUTIVE DAYS IN MOST YEARS. VERY SLIGHT DEFICIT IN THE GROWING SEASON.
PERHUMID· SOIL MOIST ALL YEAR; SELDOM DRY.
·SOIL CLIMATES·
CRYOBOREAL· COLD TO MODERATELY COLD
BOREAL· MODERATELY COOL.
BOREAL· COOL.
MESIC · MILD TO MODERATELY WARM.
MODERATELY COOL BOREAL TO MILD MESIC·

Fig. 54. Soil Climate: Moisture and Temperature Regimes, Nova Scotia.

T32 Soil Classification

The Canadian taxonomic classification has five categories: order, great group, subgroup, family, series. A generalized soils map of Nova Scotia has been produced (Canada Department of Agriculture, 1972) which groups the soils series, which number in excess of a hundred, into map units. The map units are sometimes equivalent to a soil family and sometimes contain two or more soil families. This section describes the main features and processes of the soils of Nova Scotia at the order, great group and subgroup level, with reference to map units on the generalized soils map, and to specific soil series.

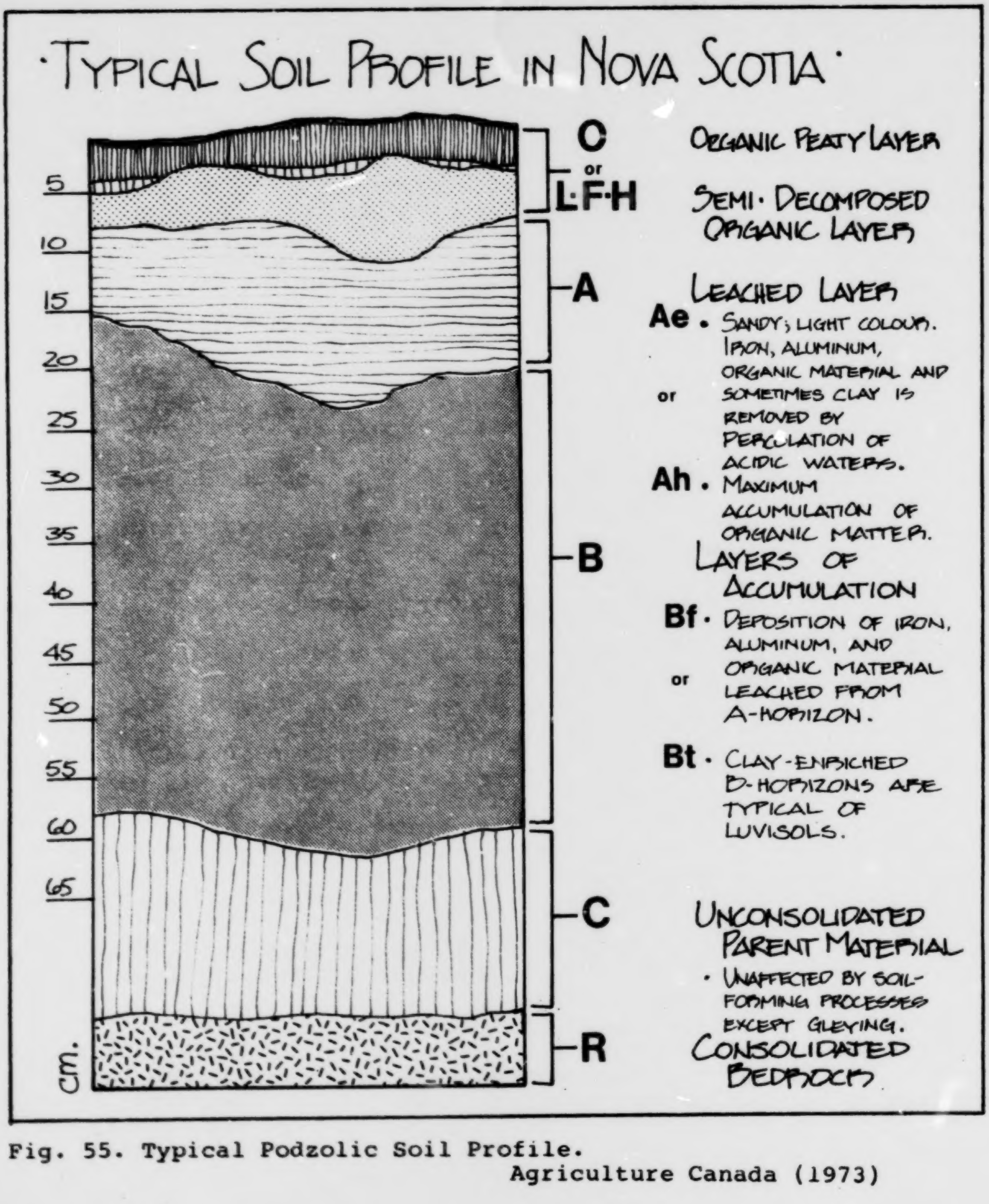
SOIL PROFILE

A soil profile is comprised of a number of layers or horizons (Figure 55). Not all horizons will be found in every soil.

Organic Layers -	O	Developed mainly from mosses, rushes and woody materials
	L-F-H	Developed from leaves, twigs, woody materials and mosses. Three designations are distinguished by the degree of decomposition.
Mineral Layers -	A	Layer of maximum accumulation of organic carbon and/or removal of materials in solution or suspension (leached layer)
	B	Layer of accumulation of materials removed from A horizon (layer of deposition)
	C	Unconsolidated parent material unaffected by most processes in A and B.
	R	Consolidated bedrock.

ORDER: PODZOLS

Podzols are the major order of soils in Nova Scotia. They form in cool, humid conditions under forest or heath vegetation. Podzolisation is the process whereby iron, aluminium and organic matter are leached from the A layer by a weak acid solution formed as rainwater drains through the mat of organic material at the surface. Part of the dissolved matter is then deposited in the B layer. Podzols are usually marked by an abrupt change of colour between the ash-coloured


·TYPICAL SOIL PROFILE IN NOVA SCOTIA·
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60
65
cm.
O
or
L·F·H
ORGANIC PEATY LAYER
SEMI· DECOMPOSED ORGANIC LAYER
A
LEACHED LAYER
Ae • SANDY; LIGHT COLOUR. IRON, ALUMINUM, ORGANIC MATERIAL AND SOMETIMES CLAY IS REMOVED BY PERCOLATION OF ACIDIC WATERS.
or
Ah • MAXIMUM ACCUMULATION OF ORGANIC MATTER.
B
LAYERS OF ACCUMULATION
Bf · DEPOSITION OF IRON, ALUMINUM, AND ORGANIC MATERIAL LEACHED FROM A-HORIZON.
or
Bt · CLAY-ENRICHED B-HORIZONS ARE TYPICAL OF LUVISOLS.
C
UNCONSOLIDATED PARENT MATERIAL
· UNAFFECTED BY SOIL-FORMING PROCESSES EXCEPT GLEYING.
R
CONSOLIDATED BEDROCK

Fig. 55. Typical Podzolic Soil Profile.

Agriculture Canada (1973)

leached layer and the carbon or iron-enriched layer of deposition. Podzolisation is most extensive in coarse, permeable soils and under coniferous forest. The annual litter fall from softwoods is small and its decomposition slow, with consequently a slow return of base elements to the soil. Podzols are acidic, with a pH of approximately 3.5 to 4.0 in the A layer rising to 4.0 to 5.5 in the B layer, and are low in organic matter and clay minerals in the rooting zone. The accumulation of leached materials in the B horizon sometimes results in the development of a pan - a compact layer with platy structure and very slow permeability, impeding drainage and root penetration.

Great Group:
Ferro-Humic
Podzol

At the great group level two main types of podzol are found in Nova Scotia. The Ferro-Humic Podzol is associated mostly with igneous or metamorphic rock on rolling or steep highland areas under hardwood vegetation, or high plateaus with deeply dissected margins (regions 200 and 300). It is also found along the coast on the quartzite headlands of S.W. Nova Scotia (unit 841). The soil is moderately coarse, very acid, stony and generally well drained. The main feature is the high concentration of organic matter in the dark-coloured B layer. These conditions favour the development of an ortstein layer. Where drainage is imperfect to poor, as on the coastal headlands, a Gleyed Ferro-Humic Podzol may develop. (For an explanation of gleying see section on Gleysols)

Great Group:
Humo-Ferric
Podzol

The Humo-Ferric Podzol, by far the most ubiquitous great group in Nova Scotia, is associated with a variety of landforms: rolling plains, till covered hills, outwash deltas, kames, kame terraces, eskers and drumlins. The Humo-Ferric Podzols differ from the Ferro-Humic Podzols in that less organic matter has accumulated in the B horizon. They develop under forest cover on coarse textured, iron-rich parent material. The soils are usually moderately well to rapidly drained and very acid. Where drainage is impeded by topography, bedrock or fragipan gleying may occur.

ORDER: LUVISOLS

The luvisols in Nova Scotia formed on finer textured glacial till and old lake deposits derived from the weaker

Carboniferous shales and sandstones. Extensive leaching still occurs, but clay minerals rather then iron and aluminium are chiefly removed from the A horizon. The soils are acidic with moderately fine texture. For this reason, and because of the compact nature of the till below, luvisols are imperfectly drained, and gleying occurs. Queens soils are typical of this group which occur throughout the Carboniferous Lowlands (region 500).

ORDER: GLEYSOLS

Gleying occurs when soil is waterlogged for a significant portion of the year. Gleyed layers are dull, olive or bluish gray often with rusty coloured mottling caused by the reduction of hydrated iron oxides. Degrees of gleying can occur in other soils but most true Gleysols are marked by a thin, usually peaty organic layer over an A layer containing little or no organic matter, over gleyed B and C horizons. Gleysols form on dense till where topography, bedrock or fragipan impede drainage. They are associated with lower slopes, kettle depressions and enclosed basins. Three Great Groups occur:

Great Group: Humic Gleysol	The Humic Gleysol has a dark 'A' horizon, and may also have organic surface horizons derived from grass, sedge, moss or forest vegetation.
Great Group: Gleysol	The Gleysol exhibits the basic properties of the order. It lacks a well developed mineral-organic surface horizon, and occurs widely in poorly drained areas.
Great Group: Luvic Gleysol	The Luvic Gleysol includes a horizon of clay accumulation. Dull colours and/or prominent mottling indicate permanent or periodic reduction.

The following soil families are gleysols: Aspotogan (regions 400, 800 and district 530), Chaswood (district 830), Joggins, Kingsville (districts 540 and unit 610) and Masstown (unit 523 and district 620).

ORDER: BRUNISOL

The Brunisols in Nova Scotia are lowland soils formed on undulating or rolling till plains. They feature a weakly developed leached layer over a B layer which is markedly brownish, but have lesser accumulations of organic matter, iron, aluminium, or clay than is found in Podzols or Luvisols. The soils are acid. The Debert soil family, which is calcareous, is the main representative of the Brunisols. These soils occur throughout districts 520, 530 and 610.

ORDER: REGOSOL

Regosols are found on stream alluvium or on tidal sediments that have been reclaimed by dyking. Because they are fairly young soils, Regosols show little profile development by leaching and weathering. They are among the most fertile soils in the province, some having their stock of nutrients replenished by frequent flooding. The Acadia soils complex (which includes soils with a range of characteristics), formed on estuarine marshlands, is only moderately acid - pH 5.6-6.0 in the top 12 inches (25 cm). The other Regosols are alluvial and more acid.

ORDER: FIBRISOLS AND MESISOLS

These organic soils are not differentiated in the N.S. Soil Survey. Organic soils form in very poorly drained depressions. Bog peats are usually derived chiefly from sphagnum mosses with a slow rate of decomposition. The resulting Fibrisol contains over 40 percent rubbed fibre material and can hold 15-30 times its own weight in water. Lowland Mesisols derive from a wider variety of plant species including sedges. They are more decomposed, may contain some mineral material and hold 1-5 times their weight in water. All organic soils are very poorly drained and extremely acid - with a pH of less than 4.5. The most common occurrence is in district 410 and in region 100.

ROCKLAND

Rockland is identified on the provincial soils map as a separate unit, but is not a discrete order. Rockland is categorized as having more than 50 percent rock outcrop. In the Cape Breton Highlands (regions 100 and 200) gneiss schist and granite predominate. Rocklands on mainland Nova Scotia are mostly found on the quartzites and granites of the Atlantic Interior (districts 410, 440 and 450) and on coastal headlands (district 850). Drainage is variable and bogs common.

T33 Soil Distribution

Nova Scotia's soils have been divided into six broad geographic areas, see Figure 56. An overview map of the Soils of Nova Scotia (1972) classifies 87 soil series into 23 map units. The predominant map units are indicated below for each of these six geographic divisions. Selected soil series are also included in the descriptions of these divisions:

1. Shallow, Stoney Humic Podzols; Rough Mountain Land, Rockland and Organics

   This area includes North Mountain; the Cobequid Hills; the Pictou-Antigonish and Cape Breton Highlands. Similar soils with a cemented 'B' horizon are also found in coastal Shelburne County (unit 841). The highlands are formed of igneous and metamorphic rock, mostly mantled by a coarse, stoney, sandy loam till. Because many of the soils have developed from basic igneous rock, natural fertility is somewhat higher than in soils formed on acid upland rock.

   The soils are shallow, stoney, usually well drained, moderately coarse textured and darker in colour than most Atlantic Interior soils. If disturbed on steep slopes they are susceptible to erosion. They normally support good growth of mixed or hardwood forest.

   Predominant Map Units: Cobequid and Lydgate.

2. Shallow, very stoney, Podzols and Gleysols; Rockland and Organics

   These soils have formed on granite, quartzite and conglomerates. Strong glacial scouring has left a thin bouldery till cover. The granitic areas are mantled with a coarse, bouldery till, on which the Gibraltar series and the imperfectly drained Bayswater series have developed. The quartzite areas are mantled with a thin, stoney, sandy loam till on which the Halifax series and the imperfectly drained Danesville series have developed. Aspotogan, a gleysol, is the poorly drained member of both the Gibraltar and the Halifax catenas. These soils are pale brown to olive gray.

   Westbrook soils are deeper but very stoney, derived from conglomerates and occur mainly in district 580 north of the Cobequid Hills.

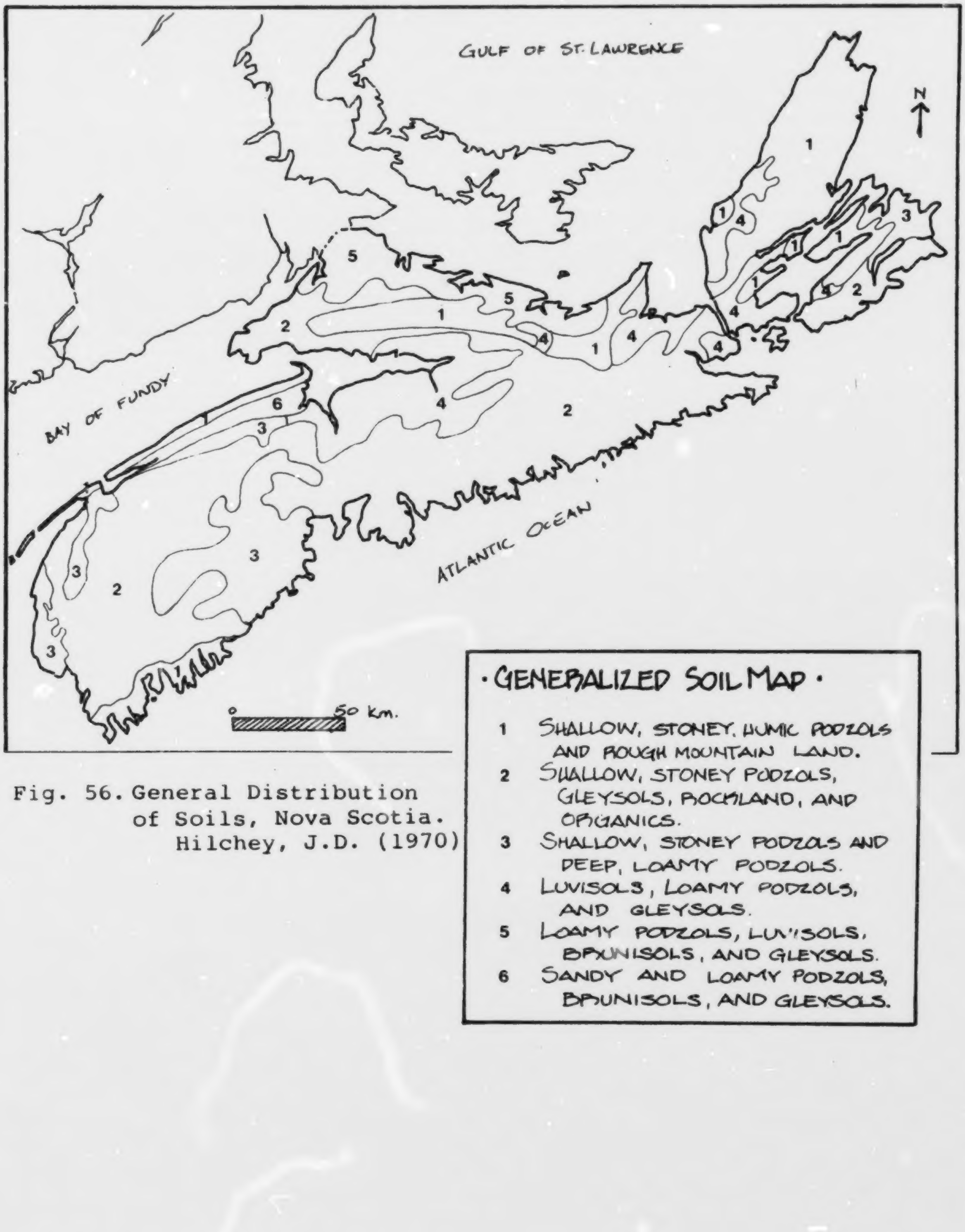

GULF OF ST. LAWRENCE
N
BAY OF FUNDY
ATLANTIC OCEAN
0
50 km.
1
2
3
4
5
6
· GENERALIZED SOIL MAP ·
1 SHALLOW, STONEY, HUMIC PODZOLS AND ROUGH MOUNTAIN LAND.
2 SHALLOW, STONEY PODZOLS, GLEYSOLS, ROCKLAND, AND ORGANICS.
3 SHALLOW, STONEY PODZOLS AND DEEP, LOAMY PODZOLS.
4 LUVISOLS, LOAMY PODZOLS, AND GLEYSOLS.
5 LOAMY PODZOLS, LUVISOLS, BRUNISOLS, AND GLEYSOLS.
6 SANDY AND LOAMY PODZOLS, BRUNISOLS, AND GLEYSOLS.

Fig. 56. General Distribution of Soils, Nova Scotia. Hilchey, J.D. (1970)

Predominant Map Units: Gibraltar, Liverpool, Aspotogan and Westbrook.

3. Very stoney loamy Podzols and Gleysols; deep loamy and stoney loamy Podzols

Podzols in this group have developed from glacial till on slate, schist and quartzite in Yarmouth and Digby Counties (district 420), on slate and Carboniferous material in Lunenburg and Queens Counties (district 430). Gleysols have developed on gray and brown Carboniferous sandstones in Cape Breton County (district 530). Slate outcrops have yielded a loamy bouldery till in the form of a drumlin field directly above and to the southeast of the outcrops. Deep podzols are found on the drumlins and shallow gleysols in between.

Predominant Map Units: Barney, Wolfville, Morristown and Aspotogan.

4. Luvisols; sandy and loamy Podzols; some Gleysols and Regosols

Moderately fine textured Luvisols, chiefly of the Queens series, are found on the Carboniferous shales and sandstones while moderately coarse textured Podzols are confined mainly to the Triassic sandstones, district 620, bordering the Minas Basin. Gleyed Kingsville soils in district 540 are distinctive. Glacial till is the predominant parent material, but in all lowland areas dykeland (Acadia) and floodplain (Stewiacke) regosols formed on marine and alluvial sediments are common.

Predominant Map Units: Tormentine, Queens, Wolfville, Kingsville, Masstown, Stewiacke and Acadia.

5. Loamy Podzols; Luvisols; Brunisols; some Gleysols, and Regosols

These soils are derived from dark reddish brown glacial till with a wide variety of textures on Carboniferous bedrock. Prominant soil series are the Humo-Ferric

Podzols of the Tormentine and Pugwash series, which are relatively stonefree, shallow friable material over compact impervious subsoil and moderately well-drained; Luvisols of the Queens series; Brunisols of the Debert series which are imperfectly drained with extensive fragipan development. Poorly drained, gleyed, Masstown soils border the organic soils of the Tantramar marshes (unit 523). Reclaimed salt marshes form the basis for the fertile gleyed regosols known as Acadia soils.

Predominant Map Units: Tormentine, Queens, Debert, Masstown and Acadia.

6. Sandy and loamy Podzols; Brunisols; Gleysols; clayey Regosols and Organics

These soils, occurring in the Annapolis Valley (district 610), have developed on red Triassic sandstones and slates, with some mixtures of basaltic rock from North Mountain. Parent materials include small areas of rapidly drained outwash delta sediments (Nictaux series), glaciofluvial sands (Canning, Cornwallis,) all of whcih are podzols; lacustrine and marine clays, on which the gleysols Lawrencetown and Fash are developed, and fine textured glacial till along the lower slopes of North and South Mountain including the Pelton, Glenmont and Morristown podzols. At the eastern end of the valley the colour of the till is modified by gray and black slates and shales, and at the western end by granite. At both ends of the valley estuarine marshlands have been dyked, producing the rich silty regosols of the Acadia series.

Predominant Map Units: Canning, Tormentine, Queens, Morristown, Debert, Kingsville and Acadia.

REFERENCES

See T32 Soil Classification, T35 Hardpans

T34 Biological Environments

Soils are the foundation of terrestrial ecosystems. They support plants, regulate the movement of water, shelter a large variety of animals and are the place where organic material is broken down, and basic nutrients returned to the nutrient cycle. The greatest amount of biological activity takes place in the A horizon just below the surface. The numbers and species of micro-organisms found will be influenced by factors including the acidity, the type of leaf or needle litter, the soil texture and the soil moisture. The soil offers a relatively constant environment without wide daily temperature fluctuation. When change does occur, as for example prolonged rain saturating the soil or frost penetration in winter, soil faunas will show marked fluctuations of numbers.

Mor Many of the surface organic layers of soils in Nova Scotia are classified as mor, which is characteristic of dry or moist acid habitats, typically under heathland or coniferous forest. Mor humus consists of a well defined, poorly decomposed matted layer of forest or heath litter over mineral soil. As coniferous trees are evergreen the annual litter fall is small, usually between 2-4 inches (5-10 cm). Conifers also take out and therefore recycle less mineral matter from lower soil layers than do broad-leaf trees. Some litters, such as pine and spruce, are high in lignin, resins and waxes and are resistant to microbial decomposition. In Nova Scotia, where podzols predominate, mor humus will often form even under mixed or hardwood forest because of the intense leaching effect of high rainfall on coarse, base-deficient soils. Fungi are the main decomposing agents in mor humus. The soil fauna is dominated by mites and springtails. The actual numbers may be high, but the total biomass will be low, and the fauna will have little mechanical influence on the soil.

Mull Under hardwood forest and where a reasonable supply of calcium is available, mull humus may develop. Deciduous trees produce 4-6 inches (10-15 cm) of leaf litter a year, and return larger amounts of nutrients to the soil.

Bacteria tend to replace fungi as the decomposers, and the soil fauna will be more diverse. The numerical population of animals may be smaller than is found in mor, but the total biomass will be much greater. Studies in Europe have shown that mull can support a biomass 200 times larger than raw spruce humus. In a rich mull 50 - 80 percent of the animals will be earthworms. In Nova Scotia true mull is not common and is mainly found on North Mountain or on the Cobequids where the bedrock is more basic.

Local Studies

The study of Nova Scotia's soils has, to date, been mostly directed towards agricultural and forestry uses. In a study of land snails in the Wolfville area, however, Moore (1963) observed that even where good moisture and shelter conditions were available, fewer numbers and fewer species than might be expected were found. This he attributed to high local acidity. In the study area, which did not include any of the lands underlain by limestone and gypsum, only 25 of Nova Scotia's 40 species were found. Another study (Reynolds 1976) identified 15 species of earthworm in Nova Scotia (as contrasted with 30 in Canada, and 60 in the United States). In an area of Gibraltar soils only 3-6 species were found, while 7-10 were found in the somewhat more productive Halifax and Wolfville series.

REFERENCES

See T31 Soil Development and Soil Climate, T35 Hardpans

T35 Hardpans

Hardpan is a hardened or cemented layer in the B horizon which impedes drainage and rooting. Two basic types of hardpan are found in Nova Scotian soils - fragipan and ortstein.

Fragipan

Fragipan is a layer cemented by clay covering grains of silt and sand. It has a platy structure and is brittle when dry. A well developed fragipan cannot be penetrated by roots and is only slightly permeable. It is more commonly found in lowland soils and is particularly associated with lowland Luvisols and Brunisols. It is estimated that fragipans affect over 40,000 acres (100,000 ha), many of them in Cumberland, North Colchester and Pictou counties (district 520), where they have formed in soils over sandy loam and loam parent materials.

A typical fragipan is often found in soils of the Debert series a gleyed degraded dystric brunisol, developed on dark red, compact glacial till. The fragipan is usually between 12-24 inches (30 and 60 cm) from the surface. Only a few fine roots are found and these are confined to the network of vertical fractures. Permeabililty is very slow. In the A horizon water drains through at a rate of 0.25-8.0 inches (0.6 to 20 cm) per hour. In the fragipan layer water drains at 0.01 inches (0.025 cm) per hour. Undisturbed Debert soils usually support growth of red and black spruce, with a ground covering of mosses. Tree throw is frequent because of the shallow-rooting.

Ortstein

An ortstein layer consists of organic matter cemented with illuviated iron, aluminium oxides and organic matter. It has been suggested that ortsteins are associated with change from a wet to a drier soil moisture regime. The cementing is caused by dessication and resultant oxidation.

Ortsteins are most commonly found in coarse-textured upland and highland soils, particularly the Ferro-Humic Podzols, which feature substantial leaching of organic matter to the B horizon. Ortsteins are found extensively in the barrens of S.W. Nova Scotia (district 440) and on the Cape Breton plateau (district 210 and region 100). A typical ortstein is often found in soils of the Lydgate series - a Gleyed Ferro-Humic Podzol common in Shelburne County (unit 841). The surface drainage is fairly rapid, but the fine, thick, organic surface layer retains moisture over long periods. The dark brown, strongly mottled ortstein layer is found at a depth of about 12 inches (30 cm). Where forested, Lydgate soils usually support only spruce. Large areas are covered with heath vegetation. Other soils which often develop ortstein layers are Nictaux, Somerset, Hebert, Bayswater and Gibraltar.

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T20 Nova Scotia's Climate, T36-48 Flora, T60 Land and Freshwater Invertebrates.

ASSOCIATED HABITATS

H9 Dykelands, H17-34 Terrestrial Habitats.

REFERENCES

Agriculture Canada (1977)
Beke and Hilchey (1978)
Brookes (1972)
Hilchey (1970)
Moore (1963)
Nova Scotia Soil Survey
Reynolds (1976)
Scott (1972)

PLANTS

T36 Algae

The plant life of Nova Scotia includes representatives of all main groups; Algae, Fungi, Bryophyta and Trachaeophyta. These plants are largely autotrophic, i.e. carrying out photosynthesis, except for the fungi and some specialized angiosperms that are heterotrophic. The trachoeophytes are the most diverse and conspicuous plants with the greatest importance to production in terrestrial ecosystems. The algae are conspicuous and very significant to production in aquatic and particularly marine ecosystems.

Algae is a name given to a diverse group of mainly aquatic, primitive plants. They have no vascular structure, and are largely dependent upon water for sustenance and reproduction. The most conspicuous occurrences of algae are the rich growths of seaweeds that occur in the littoral zone of rocky shores around the coast of Nova Scotia. There are over 325 species of seaweeds recorded from Nova Scotia. In addition there are several species of macroscopic freshwater algae. Unicellular algae are also seasonally abundant in both freshwater and marine waters of Nova Scotia. The six groups conspicuous in Nova Scotia are as follows:

Blue-green Algae	Cyanophyta (blue-green algae) are mostly associated in filaments. They live in muddy surfaces rich in organic material, in fresh and salt water, and are important to the ecosystems of mud flats and saltmarshes. Some species form a symbiotic association with fungi in lichens. (see Bird and McLachlan, 1977).
Diatoms	Chrysophyta (diatoms) are abundant in the plankton of both lakes and the ocean especially during the spring when they provide the main primary production, the "spring bloom". They are all microscopic cells but become visible in aggregations or chains, that can be numerous enough to colour the water.
Green Algae	Chlorophyta (green algae) are single cells, aggregations of cells, and macrophytes found in

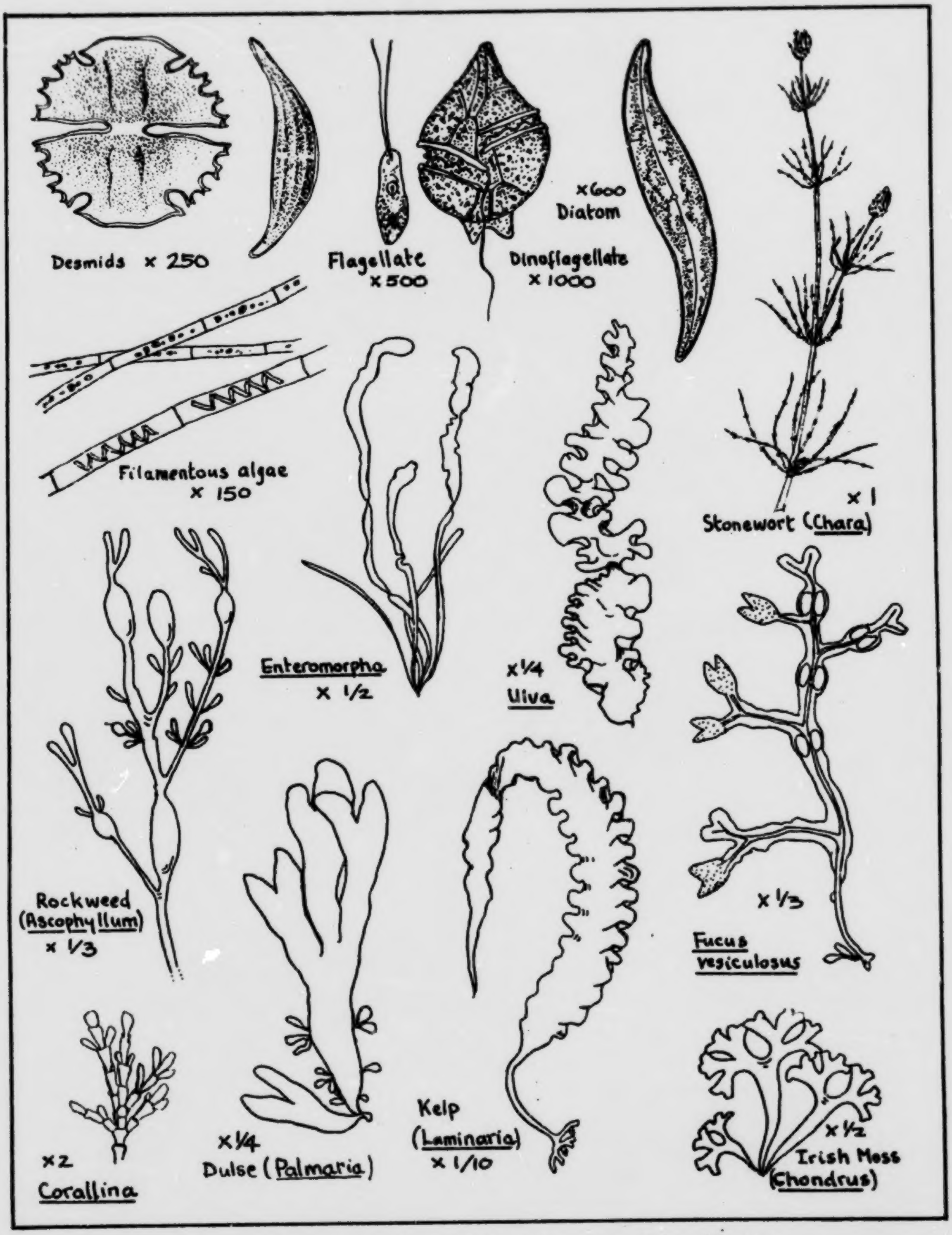

Desmids x 250
Flagellate
x 500
Dinoflagellate
x 1000
x 600
Diatom
Filamentous algae
x 150
Enteromorpha
x 1/2
x 1/4
Ulva
x 1
Stonewort (Chara)
Rockweed
(Ascophyllum)
x 1/3
x 1/3
Fucus
vesiculosus
x 2
Corallina
x 1/4
Dulse (Palmaria)
Kelp
(Laminaria)
x 1/10
x 1/2
Irish Moss
(Chondrus)

Fig. 57. Examples of Algae found in Nova Scotia (Note: enlargements or reductions are approximate).

seawater, freshwater and moist terrestrial habitats. Marine intertidal forms include *Enteromorpha*, *Ulva lactuca* and *Cladophora*. In the plankton, flagellates are important primary producers. In freshwater, filamentous forms such as *Spirogyra* and Desmids are important. Some genera, eg. *Protococcus*, live on tree trunks and are particularly conspicuous after rain.

Stone Worts Charophyta (stoneworts) are macrophytes most of which produce a calcareous supporting structure within their cells. They are important only in freshwater with high calcium content. *Chara* is common in ponds in gypsum areas in Nova Scotia and *Nitella* has also been reported from the province.

Brown Algae Phaeophyta (brown algae) are the brown seaweeds common in the marine intertidal areas, particularly on exposed rocky shores, but also in saltmarshes and on stones on muddy shores. Typical forms are the Rockweeds (*Fucus* spp. and *Ascophyllum nodosum*) and the Kelps (*Laminaria*, *Agarum cribrosum* and *Alaria esculenta*).

Red Algae Rhodophyta (red algae) are the red seaweeds that occur in the intertidal areas on rocky shores and below low water mark. They include thalloid and filamentous forms and the calcareous *Corallina officinalis* and *Lithothamnium* sp. Irish Moss, (*Chondrus crispus* and *Gigartina stellata*) and *Furcellaria lumbricalis* are important commercial species.

ASSOCIATED TOPICS

T42 Lichens

ASSOCIATED HABITATS

H2 Open Water, H3 to H7 Inter-tidal Habitats, H10 to H13 Freshwater Habitats

REFERENCES

Bird and McLachlan (1977)
Edelstein et al (1967)
Edelstein and McLachlan (1967)
McFarlane and Milligan (1966)

T37 Fungi

This is a diverse group of basically microscopic, heterotrophic plants without chlorophyll. They are mainly saprophytes inhabiting decomposing organic substrates in the soil, in freshwater and in seawater. Some species are parasitic on either plants or animals and others form a symbiotic association with either green or blue-green algae, as lichens. Fungi only become conspicuous where their filaments (hyphae) become concentrated into a mycelium on rich substrates or to facilitate reproduction. The mushrooms and bracket fungi commonly seen in forest habitats are specialized spore-producing structures. The most recent list of Nova Scotian Fungi has been published by C.O. Gourley (1983). The fungi are divided into two divisions, the Myxomycota (slime fungi) and the Eumycota (True Fungi).

Slime Fungi

Myxomycota (slime fungi) consist of a naked mass of protoplasm capable of amoeboid movement. They are often considered as being intermediate in position between animals and plants. The aggregate form is known as a plasmodium and this is most commonly seen (typically yellow masses) on damp rotting wood in forests and other shady places.

True Fungi

Phycomycetes (algae-like fungi) are composed of hyphae without dividing cell walls (coenocytic) and thus resemble some tubular, filamentous green algae. These forms are widespread and include molds, blights and parasites of insects, fish and amphibians.

Deuteromycetes (fungi imperfecti) are a widespread group of fungi in which only asexual reproduction is known. Many are responsible for plant diseases.

Ascomycetes (cup or sac fungi) are almost all saprophytic and include various molds and mildews, yeasts and Penicillium. Significant tree parasites are Black Knot in plum, Chestnut Bark Fungus, Dutch Elm disease and witches broom. Larger forms include the edible saddle fungus.

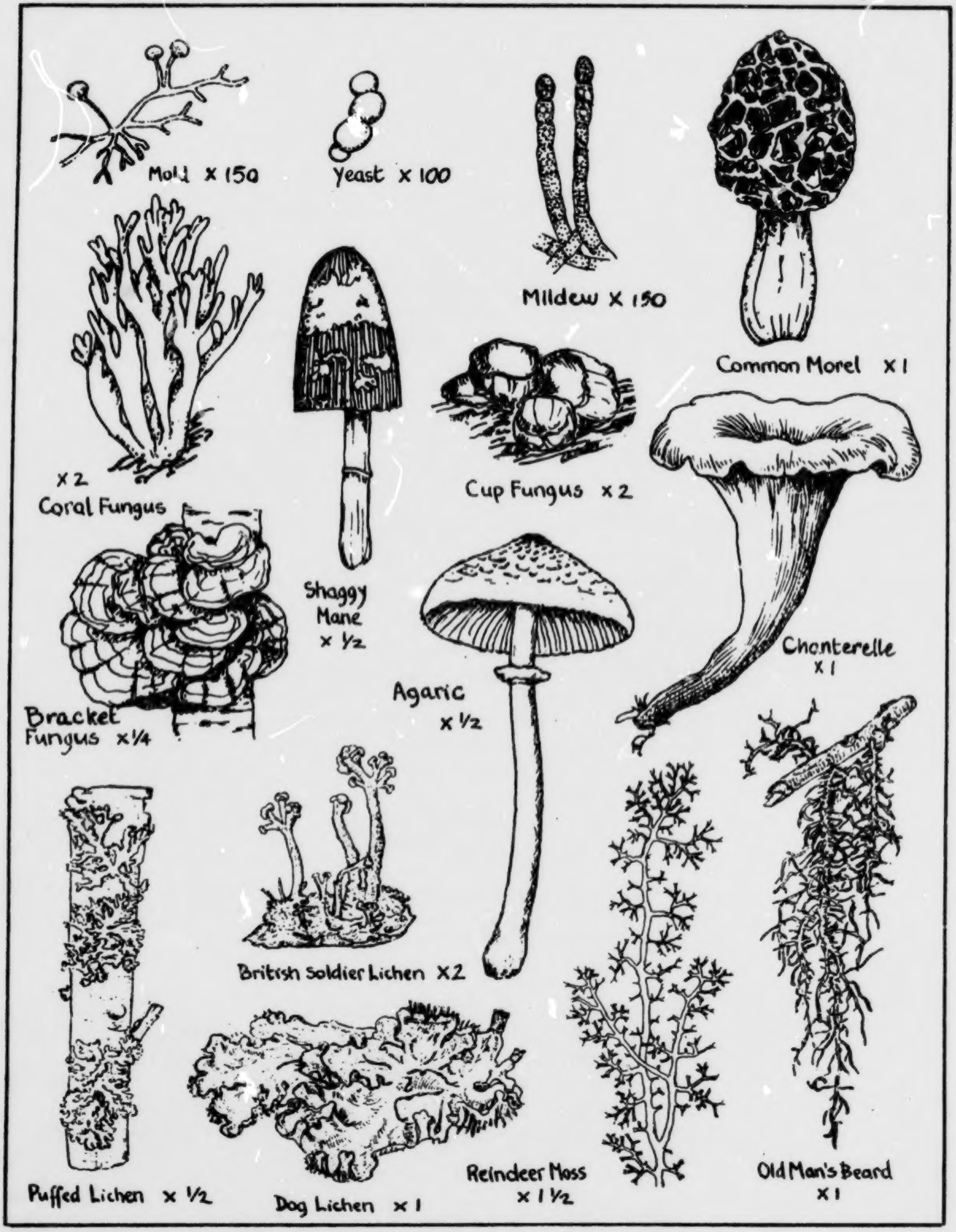

Mold x 150
Yeast x 100
Mildew X 150
Common Morel x 1
x 2
Coral Fungus
Shaggy Mane x ½
Cup Fungus x 2
Chanterelle x 1
Agaric x ½
Bracket Fungus x ¼
British Soldier Lichen X2
Puffed Lichen x ½
Dog Lichen x 1
Reindeer Moss x 1½
Old Man's Beard x 1

Fig. 58. Examples of Fungi and Lichens found in Nova Scotia (not drawn to scale).

Basidia Fungi Basidiomycetes (Basidia fungi) include mostly saprophyte species (e.g. the conspicuous gill and bracket fungi) but also parasitic forms such as the smuts and rusts of grasses and White Pine Blister Rust. The mushrooms, toadstools, and bracket fungi, commonly seen in forest and other habitats all belong to this group. As they are conspicuous, and include both edible and poisonous species, the group attracts a good deal of public interest. Many species have specific relationships with common forest trees.

ASSOCIATED TOPICS

T38 Lichens

ASSOCIATED HABITATS

H7 Salt Marsh, H17 to H34 Terrestrial Habitats

REFERENCES

Bird and Grund (1979)
Gourley (1983)
Groves (1962)
Grund and Harrison (1976)
Harrison (1961)
McAfee and Grund (1982)
Robar, Harrison and Grund (1981)
Wehmeyer (1950)

T38 Lichens

Those most marvellous examples of cooperative living (symbiosis) between Ascomycete or Basidiomycete fungi and green or blue-green algae, are often conspicuous organisms in Nova Scotia. They are common in most terrestrial habitats and create conspicuous zonation patterns on maritime rocks. Lichens can be conveniently referred to by their gross structural forms, crustose, foliose, squamulose, fruticose and gelatinous. These plants colonize tree bark, open ground and rock surfaces and form distinct successions of species on the bark of trees, parallelling the successional developments of the forest itself. Reindeer lichens (Cladonia spp.) and several others (eg. Cladonia), are important in bogs and are a dominant feature in some barren habitats, although the areal extent of this habitat type is limited. Rock tripe (Umbilicaria spp.) and other foliose and crustose lichens commonly grow upon the exposed surfaces of large boulders in barrens and rocks on lakeshores. Branches and trunks of mature coniferous and deciduous trees in the fog influenced Atlantic coastal forest are often heavily covered by hair-like lichens such as Old Man's Beard (Usnea spp.) and species of Bryoria and Alectoria. Lung lichen (Lobaria pulmonaria) and other related species, grow as an epiphyte among a variety of other less conspicuous lichens upon the trunks of tolerant hardwood trees throughout the province. Some lichens can tolerate high levels of dessication and illumination, while others depend on high humidity and shade. As they obtain much of their nutrient requirement from rainwater, lichens are highly sensitive to air-borne pollutants and in urban areas all but the most hardy species are absent.

ASSOCIATED TOPICS

T36 Algae, T37 Fungi

ASSOCIATED HABITATS

H14 Bogs, H17 Barren, H19 Cliff, H20 Talus Slope, H22 to H34 Forested Habitats

REFERENCES

Erskine (1971)

T39 Bryophytes (Mosses and Liverworts)

These are the simplest of the land plants and are often conspicuous in moist terrestrial habitats in Nova Scotia. The 1980 Check List of the Mosses of Canada lists approximately 540 taxa from the province.

Mosses (Musci) occur scattered throughout most terrestrial and many littorial aquatic habitats. Many species are rather small but some, such as the Hair Cap Moss (Polytrichum commune), are common and conspicuous on the ground in open woodland habitats. Some species may also be found on rock surfaces and on the trunks of trees. Mosses are the dominant groundcover plants in two situations in Nova Scotia. The dense canopy of most mature softwood forests creates conditions suitable for development of a moss dominated ground cover. Schreber's moss (Pleurozium schreberi, Stepmoss (Hylocomium splendens) and Broom mosses (Dicranum spp.) are dominant species under such conditions. Sphagnum mosses are dominant in wet boggy habitats where their remains accumulate during slow decomposition to form the organic substrate (peat). Various species of Sphagnum occupy a range of moisture conditions in bogs from the pond edge (S. cuspidatum) to the dry hummocks (S. fuscum).

The aquatic species such as Fountain Moss (Fontinalis spp.) are commonly found growing on rocks and boulders in stream beds and wave-washed lake shores. These plants can tolerate both submergence and exposure, as dictated by seasonal water level variations.

Erskine (1971) notes that twenty-five species of moss make up about ninety percent of the moss population of Nova Scotia.

Liverworts (Hepaticae) of both the leafy forms (Jungermaniales) and thalloid forms (Metzgeriales and Marchantiales) occur widely in moist terrestrial semi-aquatic situations in Nova Scotia. Leafy forms commonly occur with mosses in mature woodland, for example Bazzania trilobata in the moss association mentioned above. Thalloid forms such as Conocephalum conicum are often conspicuous near the water along the banks of rivers and in springs.

ASSOCIATED TOPICS

T43 Plant Communities

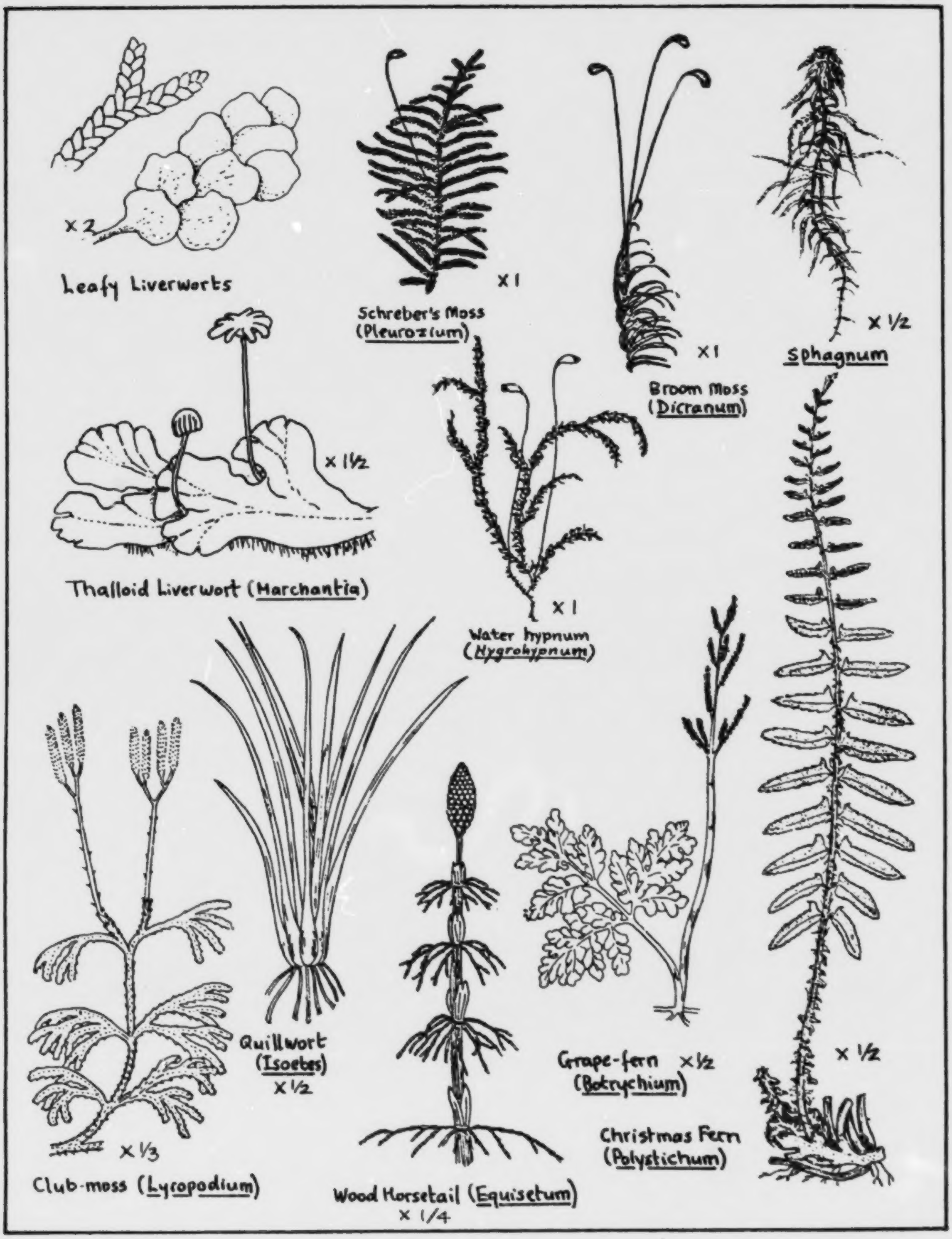

x 2
Leafy Liverworts
x 1
Schreber's Moss
(Pleurozium)
x 1
Broom Moss
(Dicranum)
x 1/2
Sphagnum
x 1½
Thalloid Liverwort (Marchantia)
x 1
Water hypnum
(Hygrohypnum)
Quillwort
(Isoetes)
x 1/2
Grape-fern x½
(Botrychium)
x 1/2
Christmas Fern
(Polystichum)
x 1/3
Club-moss (Lycopodium)
Wood Horsetail (Equisetum)
x 1/4

Fig. 59. Examples of Bryophytes and Pteridophytes found in Nova Scotia (Note: enlargements or reductions are approximate).

ASSOCIATED HABITATS

H10 to H16 Freshwater Habitats, H17 to H34 Terrestrial Habitats

REFERENCES

Brown (1936)
Erskine (1968, 1969, 1971)
Ireland (1982)
Ireland *et al* (1980)

T40 Pteridophytes (Ferns and their Allies)

Representatives of these non-flowering, vascular plants may be found in association with most terrestrial and freshwater shoreline habitats. Most species are conspicuous components of the vegetation. There are 74 species present in Nova Scotia, though some are rare or only locally common.

The Horsetails (Equisetaceae) include eight species which grow in open ground, woodland and littoral habitats. The Club mosses (Lycopodiaceae) are common in various types of woodland and are occasionally found on barrens and in bogs. Two species of Selaginella (Selaginellaceae) also occur but are relatively rare in Nova Scotia. There are four species of Quillworts (Isoetaceae) in Nova Scotia, all being asscciated with littoral freshwater habitats. True ferns play a significant role in many of the plant communities found in the province. A variety of ferns dominate the ground vegetation cover under tolerant hardwood forests throughout the province. The Wood Fern (Dryopteris spinulosa) is an important component of the boreal Balsam Fir forest on the Cape Breton Highlands (district 210), while the Bracken fern (Pteridium aquilinum) is common in the ground vegetation of open forest stands throughout much of Nova Scotia. Ferns form an important part of the arctic-alpine vegetation community found on seepy cliffs in Northern Cape Breton Island (district 220). The Cinnamon fern (Osmunda cinnamomea) is common in swamps and wet places. Hay-scented Fern (Dennstaedtia punctilobula) is found in grazed land and disturbed forests. The Ostrich Fern (Matteuccia struthiopteris) often dominates in the understory vegetation of fertile, river floodplain forests, especially in region 500.

ASSOCIATED TOPICS

T47 Plant Communities

ASSOCIATED HABITATS

H15 Fen and H16 Swamp (Wetlands), H17 to H34 Terrestrial Habitats

REFERENCES

Mahar et al (1978)
Roland and Smith (1969)

T41 Seed-bearing Plants

There are approximately 1,400 different seed bearing plants growing wild in Nova Scotia. Of these, only a small number fall into the category of Gymnosperms, those plants which have needle or scale-like leaves and bear naked seeds. They include the pines, spruces, fir, hemlock, larch and cedar which are all trees and the junipers and yew which are shrubs.

The vast majority of seed plants are angiosperms which bear flowers and have seeds enclosed in an ovary. The angiosperms are further divided into two main groups. The monocotyledons include those plants with floral parts in threes and parallel veins in the leaves. The dicotyledons have floral parts in fours and fives and net venation in their leaves.

MONOCOTS

The majority of the Nova Scotian monocots belong to the grass and sedge families. Others include the rushes, the pond weeds, the arums, the lilies, the irises, the orchids and several minor aquatic groups. All are herbaceous with the exception of Green Brier (Similax rotundifolia) which is a woody vine found in forests of the south western part of the province.

Grasses, sedges and rushes are primarily plants of open non-forested habitats. Various species within these groups dominate the vegetation in those places: bluejoint grasses (Calamagrostis canadensis) and the sedge (Carex aquatalis) predominate in the vegetation on the banks of slow flowing rivers and streams. The Spartinas (Spartina alterniflora and S. patens) perform a major role in the productive activity of salt marshes throughout the province; rushes and bulrushes are common in wet coastal areas and are prominent in ponds, at the littoral zone of lakes and slow flowing rivers and in wet roadside ditches. American Dune Grass (Ammophila breviligulata) dominates sand dune plant communities scattered around Nova Scotia's coastline.

DICOTS

The dicots form a larger and more diverse group of plants in Nova Scotia. Some are herbaceous while others are woody shrubs or trees, a few are aquatic but most are terrestrial. The most conspicuous families include the roses, the heaths, the legumes, the mustards and the composites.

These plants constitute the larger bulk of species found in the ground cover flora of open softwood, mixedwood and hardwood forests of the province. In addition, the ericacous or heath plant group, along with other dicots, forms the dominant vegetation in the Nova Scotian bogs, barrens and stream bank savannas of the Atlantic Interior (region 400). The asters (*Aster* spp.) and goldenrods (*Solidago* spp.) dominate the late summer flowering plants in recently abandoned old fields throughout the province as they grow intermingled with their earlier flowering cousins, the Daisy (*Chrysanthemum leucanthemum*), the Ragwort (*Senecio Jacobea*) and the Dandelion (*Taraxacum officinale*).

ASSOCIATED TOPICS

T42 to T47 Plants

ASSOCIATED HABITATS

H6 Mud Flat, H7 Saltmarsh, H8 to H9 Associated Coastal Habitats, H10 to H16 Freshwater Habitats, H17 to H34 Terrestrial Habitats

REFERENCES

Roland and Smith (1969)

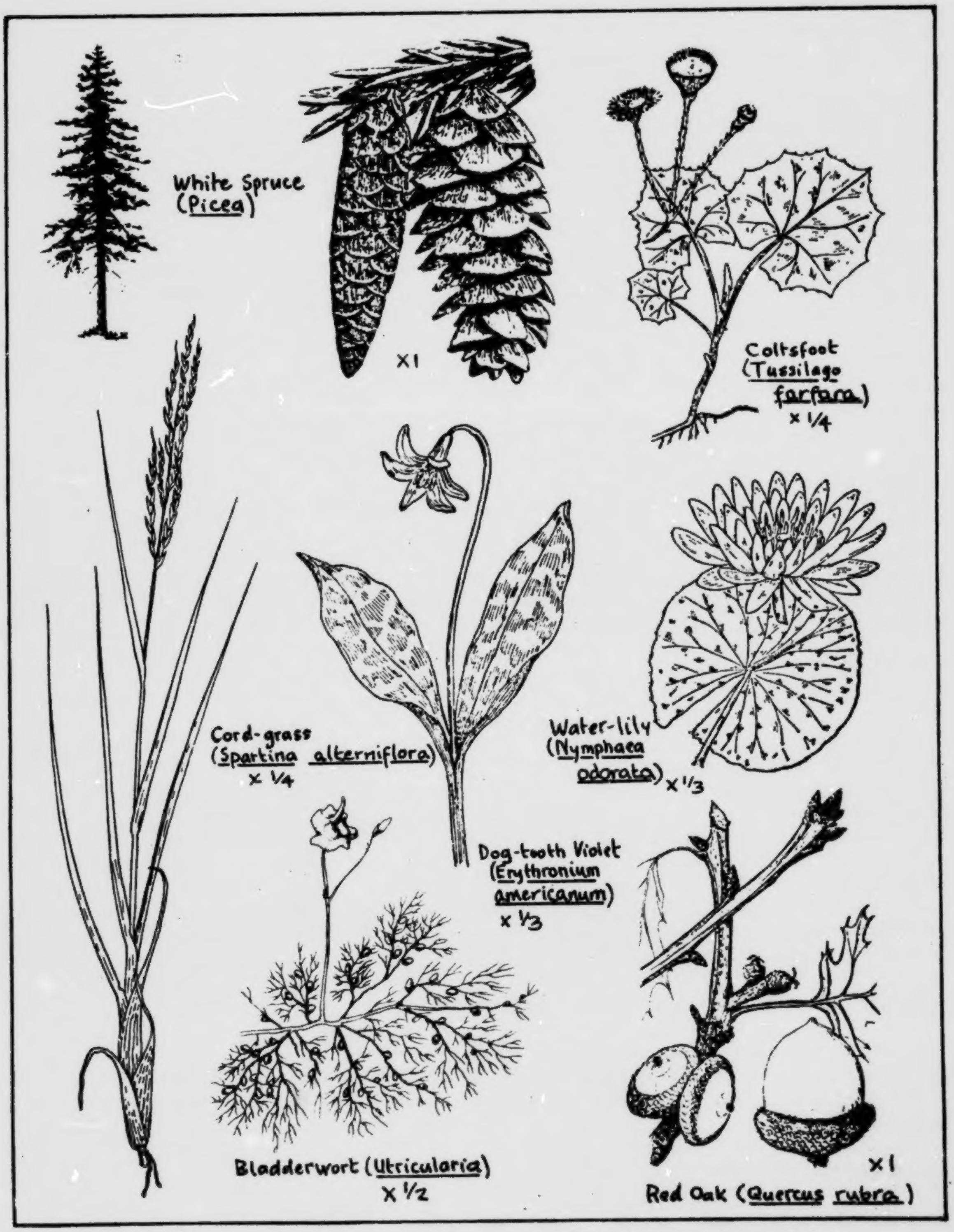

White Spruce
(Picea)
x1
Coltsfoot
(Tussilago
farfara)
x 1/4
Water-lily
(Nymphaea
odorata) x 1/3
Cord-grass
(Spartina alterniflora)
x 1/4
Dog-tooth Violet
(Erythronium
americanum)
x 1/3
Bladderwort (Utricularia)
x 1/2
x1
Red Oak (Quercus rubra)

Fig. 60. Examples of Gymnosperms and Angiosperms found in Nova Scotia (Note: enlargements or reductions are approximate).

T42 Trees

There are 30 different species of native trees in Nova Scotia. In addition, approximately 15 kinds of forest trees have been introduced to the province. The native species are grouped by most foresters into softwoods and hardwoods. The softwoods are also termed coniferous or evergreens. The hardwoods have a deciduous habit, meaning that they shed their leaves annually. Table 9 contains a summary matrix for the major silvic characteristics of the native trees of Nova Scotia.

There are exceptions to these general groupings. Larch, although normally classed as a coniferous species, nevertheless sheds its leaves annually. All conifers lose their leaves over a three to five year period and these are replaced by new needles at the growing tips of branches and stems annually. One might also question the logic of classifying trees like the aspens and poplars as hardwoods.

Hardwood trees have been subdivided into two broad groups on the basis of their ability to tolerate shade during the early stages of growth; hence the tolerant hardwoods (Yellow Birch, Sugar Maple, Beech, Ash, Red Oak and Ironwood) and the intolerant hardwoods (Red Maple, White Birch, Large Toothed and Trembling Aspen, Balsam Poplar, Grey Birch and American Elm).

Generally speaking, hardwood species prefer the better drained sites. Tolerant hardwoods constitute the climax species on the slopes and well drained hilltops throughout the province. The softwoods are more typical of the imperfectly and poorly drained sites in Nova Scotia. Red Spruce, White Pine and Hemlock form the climax forest type in the flatter, moderately well-drained sites. When the topography is mixed and rolling the climax vegetation types approach the regional climatic climax, the "Eastern Hemlock, White Pine Northern Hardwood" forest of Nichols (1935).

ASSOCIATED TOPICS

T41 Seed-bearing Plants, T43 Plant Communities in Nova Scotia, H44 Vegetation Change, T45 Successional Trends in Vegetation, T46 Vegetation and the Environment, T49 Forest and Open Habitat Birds

ASSOCIATED HABITATS

H9 Dune System, H15 to H16 Wetlands, H17 Barren, H18 Oldfield, H20 Talus Slope, H22 to H34 Forested Habitats

Table 9. Characteristics and Site Preferences of Native Nova Scotian Trees

Species	Shade Tolerance	Moisture Status	Topography	Common Reproductive Method	Successional Status	Life* Span
Softwoods						
Balsam Fir	Moderate	Moist/dry	Highlands, Rolling Lowlands, Exposed coastal Headlands	Seed	Early pioneer	1
Red Spruce	High	Moist/dry	Rolling Lowlands	Seed	Late near climax	3
White Spruce	Low	Moist/dry	Abandoned fields, Exposed coastal Headlands	Seed	Early pioneer	2a
Black Spruce	Low	Wet	Shallow Organic	Seed & Vegetative	Early pioneer	2a
White Pine	Moderate	Moist/dry	Sandy Lowlands	Seed	Early pioneer, old fields & post fire	3
Hemlock	High	Moist	Ravines & slopes, Lowlands	Seed	Mid to late near climax	3
Red Pine	Low	Dry	Sandy Lowlands	Seed	Early post fire pioneer	2a
Larch	Low	Wet	Swamps/Bogs, Moist old fields	Seed	Early pioneer	2a
Jack Pine	Low	Dry	Shallow, rocky fire barrens	Seed	Early post fire pioneer	2a
Cedar	Low	Wet/Moist	Swamps	Seed	Early pioneer	2a
Hardwoods						
Red Maple	Low	Wet/dry	Swamps to Uplands	Seed & Vegetative	Early pioneer	2b
Yellow Birch	Moderate	Moist/dry	Slopes & Uplands	Seed	Mid to late near climax	2b

* Life Span: 1 - 50-100 years
2a - 100-150 years
2b - 100-350 years
3 - 250-450 years

Table 9 (cont.)

Species	Shade Tolerance	Moisture Status	Topography	Common Reproductive Method	Successional Status	Life Span
Hardwoods (cont'd)						
Sugar Maple	High	Moist/dry	Deep soils on slopes & uplands	Seed & Vegetative	Late near climax	2b
White Birch	Low	Moist/dry	Steep slopes, Burned Lowlands	Seed	Pioneer	2a
Mountain White Birch	Low	Moist/dry	Cooler maritime areas, High elevations	Seed	Pioneer	2a
Large Toothed Aspen	Low	Moist/dry	Rolling topography after burns	Vegetative	Pioneer	1
Trembling Aspen	Low	Moist/dry	Rolling topography after burns	Vegetative	Pioneer	1
Balsam Poplar	Low	Dry	River flood-plains in Cape Breton	Vegetative	Pioneer	1
Beech	Moderate	Moist/dry	Hills	Seed	Mid to late near climax	2b
Red Oak	Moderate	Moist/dry	Hills	Seed	Early to mid pioneer	2b
White Ash	Moderate	Wet/moist	Hills Swamps	Seed	Mid to late near climax	2b
Grey Birch	Low	Moist/dry	Hills after fire	Seed	Early pioneer	1
American Elm	Low	Moist	River flood-plains, Occasional uplands	Seed	Early pioneer	2b
Black Ash	Moderate	Wet/moist	Swamps & river intervals	Seed	Mid to late near climax	2b
Ironwood	High	Moist/dry	River flood-plains, Uplands	Seed	Late near climax	2b

T43 Plant Communities in Nova Scotia

Plants grow where they do for a reason. Among the most significant factors affecting the colonization and growth of plants are: (a) the availability of light, (b) soil moisture conditions, (c) nearness of a seed source, (d) animal activity, (e) soil fertility, (f) leaf litter fall in the case of forest under-story plants and (g) site history. Each species of plant responds to varying combinations of these environmental factors. Their propagules may either establish themselves and the plant may grow and thrive, or they may not grow at all under the prevailing set of site conditions. They may germinate but find the site and its environmental conditions marginal, in which case the plant might grow although probably not in abundance. Each species has a set of conditions under which it makes optimum growth. Generally, assuming availability of growth requirements, species with similar sets of requirements will be found growing together. These cohesive recurring groups of plants when classified form the plant communities of the province. In most instances one or several species will assert dominance by being more abundant and more influential than the others. Most plant communities also have characteristic species which, although not dominant, are found most commonly, if not solely, within that community type.

A PLANT COMMUNITY CLASSIFICATION FOR NOVA SCOTIA

Even though the vegetation of Nova Scotia has been heavily disturbed by human activity, it has been possible to define broad plant community types within which much of the province's vegetation can be placed. Each community of plants varies in its composition of species and in their respective relative abundance at specific locations. The amount of variability from site to site in both species, composition and abundance within any community type is usually great. However, despite this factor, the assemblage of plants present and the relationship between those plants show a recurring basic unity from one example of the plant community to another across the province.

Table 10 contains a list of common forest plant communities found in Nova Scotia. Table 11 lists the non-forest plant communities for the province. General descriptions of these communities and their successional status have been included in the Habitat section.

The ground cover vegetation in forest plant communities is characterized by one of the following plant associations:

(a) Bracken Fern (*Pteridium aquilinum*)
(b) Humus-Moss (Primarily Schreber's Moss, Step Moss and Broom Moss)
(c) Cinnamon Fern (*Osmunda cinnamomea*)
(d) Sedge-Sphagnum (*Carex stricta* and *Sphagnum fallax*)
(e) Woodfern - Wood Sorrel (*Dryopteris spinulosa* - *Oxalis montana*)
(f) Fern-Striped Maple (various ferns and *Acer pennsylvanica*)

General descriptions of the small plant associations found in forest plant communities accompany the habitat descriptions of this document. There remains a great deal of research to be done in order to confirm the presence and completeness of these plant communities especially for central and northern Nova Scotia.

ASSOCIATED TOPICS

T31 to T35 Soils, T36 to T48 Plants, T48 Factors Influencing Avifauna, T49 Forest and Open Habitat Birds, T50 Birds of Prey, T51 Wetland Birds and Waterfowl, T52 Shorebirds

ASSOCIATED HABITATS

H7 Saltmarsh, H8 to H9 Coastal Habitats, H10 to H16 Freshwater Habitats, H17 to H34 Terrestrial Habitats.

REFERENCES

Eastern Ecological Research Ltd. (1978)
Forest Management Institute (1975)
Loucks (1962)
Nichols (1935)
Stanley *et al* (1973)

Table 10. Major Forest Plant Communities of Nova Scotia

Forested Plant Community	Percent Area of Nova Scotia*	Typical Habitat	Origin	Successional Status
1. Red Maple, Oak, White Birch (aspen)	10.0	Well drained rolling hills	Fire	Early pioneer
2. Red Spruce, Fir, Pine	3.0	Imperfect/Well drained lowland	Fire	Early pioneer
3. Red Spruce, Fir, Pine-Red Maple, White Birch	6.0	Imperfect/Well drained lowland	Cutting/ Fire	Advanced pioneer
4. Red Spruce, Hemlock, Pine (Maple, Birch)	9.0	Imperfect/Well drained lowland/ Slopes	Natural/ Cutting	Near Climax
5. White Spruce	10.0	Imperfect/Well drained fields	Cultivation	Pioneer
6. Sugar Maple, Yellow Birch, Beech	9.0	Well/Rapidly drained uplands/Slopes	Natural/ Cutting	Near Climax
7. Pine (White, Red and jack)	2.0	Well/Rapidly drained sand plains/Barrens/ Fields	Fire/ Cultivation	Pioneer
8. Red Spruce, Fir	11.5	Poor to imperfectly drained lowlands	Natural/ Cutting	Pioneer
9. Red Spruce, Fir-Maple	12.5	Poorly drained swamps	Natural	Pioneer
10. Fir	14.0	Imperfect to well drained boreal plateau/ Hilltops	Natural	Near Climax
11. White Spruce, Fir-Red Maple, White Birch	3.0	Imperfect to well drained coasts	Natural/ Cutting	Near Climax
12. Black Spruce, Tamarack	10.0	Poorly drained bog/Swamp	Natural	Pioneer
13. Sugar Maple, Elm (Balsam Poplar)	--	Well drained floodplains	Natural	Near Climax
	100.0			

*Data derived from N.S. Lands and Forests sample plot, data summaries.

Note: Where Red Spruce is named, this may include Black Spruce or a Red-Black hybrid.

Table 11. Major Non-Forest Plant Communities of Nova Scotia

	Plant Community	Typical Site Characteristics	Origin
1.	Sphagnum Moss - Cranberry	Bogs (ombrotrophic mires)	Natural
2.	Cattail	Shallow lakes & ponds	Natural
3.	Blue-joint Grass- Spiraea - Sweet Gale	Streambank (Sedge ferns)	Natural
4.	Leatherleaf - Rhodora	Streambank (Sedge ferns) bogs and bog edges mainland N.S.	Natural/Fire
5.	Water Lily - Pond Lily	Streams/shallow lakes	Natural
6.	Speckled Alder	Stream banks/Old fields	Natural/ Cultivated
7.	Crowberry	Coastal headlands and bogs	Natural/ Salt Spray/ Exposure
8.	Broom Crowberry	Barrens	Severe repeated fire
9.	Reindeer Moss - Blueberry	Barrens/ C. B. Highlands	Fire
10.	Huckleberry/ Lambkill	Fire Barrens/ Mainland N.S.	Fire
11.	Marram Grass	Sand Dunes	Natural
12.	Rush - Goldenrod	Gravelly lake shore (S.W. Nova Scotia)	Natural
13.	Royal Fern - Sweet Gale	Peaty lake shore (S.W. Nova Scotia)	Natural
14.	Bent grass - Poverty Grass	Abandoned Fields	Cultivation
15.	Cord grass (*Spartina alterniflora*)	Lower saltmarsh	Natural
16.	Marsh Hay (*Spartina patens* and *S. pectinata*)	Upper saltmarsh	Natural

T44 Vegetation Change

HISTORIC VEGETATION OF NOVA SCOTIA

The primary sources of information about the primeval vegetation of Nova Scotia are the recorded notes of Nicholas Denys (1600's) and Titus Smith, Jr. (1801-02). The maps in the report "Forest Conditions of Nova Scotia" compiled by Fernow (1912) provide a further important source of historic information. Pollen profile analysis from peat bogs and lake bottom sediments allowed researchers like Livingstone (1968) Railton (1975), Deevey (1951) and Ogden (1960) to document major changes in the province's vegetation during post-glacial times. These are of little value, in identifying the nature of vegetation change within the recent past. One is left primarily with projections back in time based upon the present vegetation of the province, for which comprehensive detailed mapped information is scant.

The major types of forest and non-forest plant communities in Nova Scotia have probably not changed dramatically during the past several hundred years. They were in all likelihood similar to those listed in Tables 10 and 11 for the present day vegetation. The proportion of the overall vegetation mosaic occupied by each of these vegetation types has undoubtedly changed dramatically as a result of human settlement, fire and insect plagues. The province today contains few examples of undisturbed climax forest plant community types. Most of the province's forests are of pioneer successional status following fire, cutting or agricultural activity.

The role of individual species within some forest types may be less significant now because they have been affected by insect infestation or have been removed through selective cutting (e.g. birch, Red Oak, Hemlock, White Pine).

FACTORS CAUSING CHANGE

Many factors have caused change in the province's vegetation. Two major groups are evident: (a) those generally considered to be natural (i.e. wind, insects, some fire and natural processes) and (b) those attributable primarily to human activity (most fires, harvesting and afforestation, agricultural use and land clearing and urbanization).

NATURAL CHANGE AGENTS

Wind

Winds have an ever present influence upon our forests. They cause the "krummholz" effect as they sweep in on coastal forests. Wind-caused dessication probably limits growth of many upland forests, including the Cape Breton Highlands coniferous forests where height rarely exceeds 30-50 feet (10 to 15 m) and strong winds blow down individual old and shallow rooted trees during storms. Occasionally storm events are so severe that massive windfall occurs in forests. Stanley *et al* (1973) drew attention to the possibility of an 80 year cycle for this massive destruction. Titus Smith frequently mentioned the tangle of wind thrown trees in southern and eastern Nova Scotia through which he had to make his way in the early 1800's. The "Saxby Gale" in 1869 caused major destruction of forests. Hurricane Edna in 1954 had similar effects. Wind has been a particularly destructive force in the shallow rooted coniferous forests of Nova Scotia.

Insects and Diseases

Every tree species has its insect pests. These are generally species specific and eliminate their host species selectively from a forest. When forests are monospecific and have limited diversity, sustained insect infestations can be catastrophic. This phenomenon has occurred in Nova Scotia with the recent spruce budworm infestation of the boreal Balsam Fir forests of Cape Breton Highlands (district 210), where a very high degree of mortality in the forests will bring about massive changes in the vegetation structure. During the 1920's Beech trees throughout the province fell prey to the Beech Bark disease which eliminated most Beech and left a legacy of cankered small Beech trees. In the 1930's White and Yellow Birch were destroyed in much of the province by the Birch Dieback Disease. Red Oak was host to an infestation of the European Winter Moth during the 1940's. White Pine trees are deformed by the White Pine Weevil. The Larch sawfly has regularly destroyed pure larch stands. Balsam Fir trees are frequently weakened by the Balsam Woolly Aphid and the Hemlock Looper creates havoc in Hemlock and other pure coniferous stands.

Collectively these insect pests and diseases have been major agents for change within forest stands in Nova Scotia and on occasion have greatly influenced forest types over large areas.

Natural Processes

Every forest stand inherently grows toward change: seeds germinate, trees grow and become decadent, other trees replace them. If unaffected by other change agents forest stands will change naturally, with species which are better adapted to the site and its environment replacing their predecessors. The main shade tolerant species will, over time, replace the shade intolerant ones. As moisture conditions inevitably evolve from wet (hydric) and dry (xeric) toward moist, the more mesic species replace the hydric species. If left undisturbed, this vegetation change process results in a forest type which changes little, for at a late stage in evolution the forest reproduces itself and is fully adapted to environmental conditions of the site. In Nova Scotia this process of natural evolution leads to a coniferous forest climax of White Pine, Eastern Hemlock and Red Spruce in lowlands and to a tolerant hardwood forest of Sugar Maple, Yellow Birch and Beech on well-drained uplands. Intermediate sites typically have a mixed wood climax of Eastern Hemlock, White Pine, Sugar Maple, Yellow Birch and Beech. Few examples of undisturbed climax forest exist in Nova Scotia.

ASSOCIATED TOPICS

T15 Post-glacial Climatic Change, T16 Colonization by Plants, T45 Successional Trends in Vegetation, T46 Vegetation and The Environment, T47 Rare Plants

ASSOCIATED HABITATS

H7 Salt Marsh, H8 to H9 Associated Coastal Habitats, H11 to H16 Freshwater Habitats, H17 to H34 Terrestrial Habitats

REFERENCES

Deevey (1951)
Fernow (1912)
Livingstone (1968)
Ogden (1960)
Railton (1975)

T45 Successional Trends in Vegetation

Each change agent has a predictable impact upon the vegetation type which it influences and it is possible to describe what the result on vegetation will be when such changes occur. The descriptions presented here are generalizations of the effects which each change agent may bring about in the various vegetation types.

NATURAL

Forest vegetation on most poorly drained and moist sites within Nova Scotia evolves toward a softwood regional climax forest type composed of various mixtures of Red Spruce, Eastern Hemlock and White Pine. Well-drained upland sites, if left undisturbed, will evolve toward hardwood regional climax forest types dominated by Sugar Maple, Yellow Birch, Beech and other northern tolerant hardwoods. The generally accepted theoretical climatic climax forest for Nova Scotia and much of north eastern North America is the Eastern Hemlock, White Pine, northern hardwood forest. Plant ecologists believe that the physiographically controlled regional climax forests (Red Spruce, Hemlock and White Pine; and Sugar Maple, Yellow Birch, Beech) if left to evolve naturally would develop in equilibrium with the climatic conditions of the region.

The highlands of northern Cape Breton are (regions 100 and 200) characterized by a unique boreal climatic regime, and the climax forest for this part of Nova Scotia is a seventy year-old Balsam Fir forest. The dominant factors maintaining such a forest type are climate, and very probably, recurring insect infestations.

Generally, most of the non-forest climax plant communities which occur in Nova Scotia (bogs, salt marshes) are sustained by some ever-present environmental factor (high water table, flooding, etc.) which prevents these communities from eventually becoming forests.

FIRE

The impact of fire upon vegetation varies with the local moisture conditions, the original vegetation, and with fire climate changes. Fire frequently destroys most, or all, of the existing vegetation cover. Occasionally small patches are left unburned and individual trees may survive. From time to time fires will burn through the understory of a forest stand and leave the overstory virtually intact. These residual trees and forests, together with the surrounding unburned forests, act as seed sources for recolonization of burns. Seeds from tree species like the pines, beeches and oaks may survive fire in situ. Species which sprout from a root system are early post-fire immigrants (for example, maples and aspens). Fires often expose a mineral soil surface as a base for recolonization. Herbaceous vegetation moves into a burnt-over area quickly. On well-drained deep soils the early post fire forest type is usually a mixture of intolerant hardwoods (Red Maple, White and Wire Birch, the aspens and, in southwestern Nova Scotia, Red Oak). Intolerant hardwoods also colonize the more imperfectly drained sites, frequently in combination with Black Spruce, Fir and Red and White Pine. Black Spruce, White and Red Pine and Fir also follow fire on heath covered post-fire sites throughout southwestern Nova Scotia, where soils are often sandy, rocky, and mineral depleted.

On the most sterile, shallow-soil sites and where frequent fires have burned the vegetation overlying bedrock, the vegetation cover is transformed to a barren characterized by low woody shrubs (Lambkill, Rhodora, Huckleberry and Blueberry), lichens and mosses. When seed sources exist on such sites e.g. Blandford, Neils Harbour (district 210), Oxford (unit 532) Jack Pine occasionally mixed with Red Pine follows severe fires, where it grows in an open savannah like forest. Occasionally, when mineral soil is exposed White Spruce trees enter a forest cover type following fires (for example, MacKenzie Mountain, near Pleasant Bay in Cape Breton, district 220).

In southwestern Nova Scotia, particularly district 440, the Eastern Shore and northeastern Cape Breton Highlands, the recurrence of fire on some poor sites has resulted in the creation of permanent low shrub barrens. In the most impoverished of these barrens vegetation change occurs very slowly. In 1912 Fernow calculated that nearly 20 percent of the province was in a barren state. By 1958 Hawboldt and Bulmer indicate that the amount of old burn and barren land had been reduced to 8 percent.

FORESTRY

It is difficult to describe the successional trends which follow forest cutting activities in Nova Scotia because, over time, varied techniques have been used in a diversity of forest cover types. Under a selective regime of harvesting, the trees that were not cut or damaged would become the main components of the subsequent forest. Significant changes occurred in the dominant species of a forest type under these conditions, although the regenerating forest type would resemble the original forest. With the opening up of a forest stand the less shade tolerant species like Balsam Fir, Red Maple, White Birch and aspen become more important. The resulting stands would be composed of multi-aged trees, and over time the shade intolerant trees would be crowded out by the more shade tolerant Sugar Maple, Yellow Birch, Hemlock and Red Spruce.

Harvesting techniques which involve "clearcutting" of a forest type, (substantial or total removal of the tree canopy) have a far reaching impact upon the successional vegetation on those sites. Clearcutting could be compared to fire in this regard. With the removal of trees, herbaceous vegetation inevitably invades a forest site often choking out the shade loving ground cover vegetation and tree seedlings which remain. Sun seeking species like white birch and aspen spread into these clearcuts. Red Maple stumps send up many new stems. Balsam Fir seedlings establish themselves in the organic surface layers along with Red Spruce on the moister sites. Mixed wood forest types are encouraged. In time the more shade tolerant Hemlock, Red Spruce, Sugar Maple and Yellow Birch become established under the canopy of undisturbed post-fire mixed wood stands. Former stands of spruce and fir on moist sites often regenerate into dense spruce and fir.

INSECT INFESTATIONS

Insects which primarily attack individual species have a similar effect to selective cutting on the forest. Although the species attacked is often removed from the forest canopy there is no dramatic change in the structure of multispecies stands. The space occupied by the removed species is simply assumed by regeneration from the forest understory. When little species diversity exists in forest stands (for example, in the boreal Balsam Fir forest on the Cape Breton Highlands, district 210) insect infestations can have catastrophic influences. Much of the original Balsam Fir boreal forests of Cape Breton will turn to young White Birch stands over the next 15 years; a dramatic change brought on by the Spruce Budworm infestation. The Hemlock Looper and the Larch Sawfly have been known to destroy sizeable patches of Hemlock and Larch forests respectively.

LAND ABANDONMENT FOLLOWING FARMING

Over the past 70 years there has been a dramatic decline in the amount of land being cultivated for agricultural use. Much of the abandoned agricultural land was only marginally productive.

In most instances and depending upon the type of farming practiced, the abandoned fields are first colonized by a variety of grasses and annual herbs. On well drained sites in the Annapolis Valley (region 600), central and eastern parts of the province (region 500), White Spruce in pure stands invade the herb-covered old fields. A monoculture of White Spruce results. Speckled Alder precedes the White Spruce and Larch on more poorly drained soils throughout most of Nova Scotia. Old abandoned well drained farm fields in the drumlinoid landscape of southwestern Nova Scotia (district 430) are colonized by pure stands of White Pine, a phenomenon which recurs in New England. Unfortunately for lumbermen these White Pine trees are infested with the White Pine Weevil which causes deformation in their normal growth. Old field White Spruce stands, if not harvested, begin to break up when the trees approach 100 years of age. The invasion of Balsam Fir and occasionally tolerant hardwoods into the understorey signals this stage in evolution. When unaffected these stands eventually approach the climax vegetation types for the region and site where they occur.

WINDFALL

Most windfalls are individual trees which blow down within a stand which is otherwise unaffected. When whole stands are destroyed by wind the result is a tangled mass of coniferous biomass. If the trees are not removed, the understorey vegetation eventually reaches up through the fallen trees which continue to provide a measure of shade. In many cases the major species of the original coniferous forest will remain dominant.

URBANIZATION

In most cases urban developers remove the natural vegetation and replace it with pavement, buildings, grass and introduced shrubs and trees. Most of the vegetation grown in these habitats does not reproduce and spread. Urban environments and waste places are characterized by the presence of annual weedy species. The majestic American Elm population characteristic of many of our towns and cities has, in recent years, fallen prey to the Dutch Elm Disease; an introduced epidemic. Where the elms were a major factor in the urbanized environment their loss will bring about dramatic changes in the appearance of our small towns.

ASSOCIATED TOPICS

T18 to T20 Climate, H36 to T47 Plants, T49 Forest and Open Habitat Birds, T59 Land and Freshwater Invertebrates

ASSOCIATED HABITATS

H7 Salt Marsh, H8 to H9 Associated Coastal Habitats, H10 to H16 Freshwater Habitats, H17 to H34 Terrestrial Habitats

T46 Vegetation and the Environment

The present landscape of Nova Scotia represents the accumulation of systematic and interactive responses between geology, landform, climatic influence, vegetation development and human involvement over thousands of years.

VEGETATION AND CLIMATE

From the most general approach the vegetation of the province, as it reflects climate, may be subdivided into three broad landscape regions. All of mainland Nova Scotia and the lowlands of Cape Breton Island are characterized by a similar climatic region. Here the Acadian Forest, typical of much of northeastern North America, flourishes with its giant melting pot of Boreal, Canadian and Alleghenian tree species. Variety abounds. Where elevations increase above 1,100 feet (330 m) on the highlands of Cape Breton (region 100 and district 210) climatic conditions become more severe; winters are much longer, snowfall is greater, persistant winds are stronger, and mean annual temperatures are lower. These boreal conditions cause the formation of a much less diverse forested landscape, characterized by wind stunted pure stands of old growth Balsam Fir over much of the land. At even higher elevations, over 1,500 feet, (450 m) the boreal landscape in Cape Breton gives way to a Boreal-Tundra transition (Taiga, region 100), a gnarled, windswept, dwarf vegetation composed of Balsam Fir, Black Spruce and Larch interspersed on poorly drained lands with extensive blankets of peatlands developed from sedge and sphagnum moss.

The Acadian Forest, along its more exposed ocean flanks, is so influenced by seawinds and salt spray that the identification of a separate coastal vegetation landscape region (region 800) is justified.

VEGETATION AND LAND FORM

Within the broad climatic and geologically controlled landscape regions of the province, vegetation responds locally to physiographic and landform variation. Landform variation is endless; hills and swales, outwash plains and till moraines broad expanses of rolling terrain, river, floodplains, steep ravine walls, eskers and drumlins, barren lands and bogs, coastal beaches in infinite variety. Recurring patterns of these elements form relatively homogeneous districts which characterize the Nova Scotia landscape. Although the relationships between vegetation types and landforms are imperfectly understood, the primary causal factors are thought to be soil moisture and stand history.

Table 12 taken from the "Biophysical Classification of Kejimkujik National Park" (1975) provides evidence for a clear relationship between soil moisture and forest stand occurrence.

TABLE 12

Proportion of Soil Drainage Class Occupied by Forest Types

		Kejimkujik National Park*				
	SL-M	SF-M	SFP-MB	P	MOB-PS	TOTAL
Rapid					65	100
Well			20	10	29	100
Moderate	17	20	34			100
Imperfect	64	17				100
Poor	64	17				100
Very Poor	91					100

*Forest types occupying 10 percent or more of specified soil drainage class.

SL-M = Red or Black Spruce, Larch - Maple
SF-M = Red or Black Spruce, Fir - Maple
SFP-MB = Red or Black Spruce, Fir, Pine - Maple, Birch
P = Pine
MOB-PS = Maple, Oak, Birch - Pine, Red or Black Spruce

N.B. Kejimkujik National Park occupies part of districts 410, 430 and 450.

SOIL AND VEGETATION

The soils of the province have evolved over ten thousand years at the interface between mineral substrate and vegetation. Endless variations in soil horizons, chemistry, fertility and texture occur. As the products of vegetative growth die and decompose the flushing action of rain water seeping through the mineral substrate carries the decomposed organic matter down through the soil profile. The products from decomposition of coniferous tree detritus tend to be more acidic and provide less fertility to a soil horizon than deciduous tree litter. As succession occurs, and coniferous and deciduous forest types exchange dominance on a site, the influences upon soil forming process vary greatly from this factor alone. The nature of these processes are not sufficiently understood to provide full knowledge of the longer term changes and relationships which exist between vegetation and soil.

ASSOCIATED TOPICS

T11 to T14 Landscape Development, T18 to T20 Climate, T31 to T35 Soils

T47 Rare Plants

A rare plant may be either restricted to a small geographic area or it may be one which occurs infrequently over a larger area. Roland and Smith (1969) commented on the rarity of certain species of vascular plants in Nova Scotia. Mahar et al (1978) prepared a list of 222 species in Nova Scotia which are considered to be rare. Many of these are at the limits of their range and are more common elsewhere.

"A threatened plant is one that is likely to become endangered within the foreseeable future over all or a significant portion of its range" (Mahar et al, 1978). Drs. P. Keddy and A.E. Roland have proposed the following list of threatened species in Nova Scotia.

Adiantum pedatum var. pedatum	Maidenhair Fern
Allium tricoccum	Wild Leek
Caulophyllum thalictroides	Blue Cohosh
Coreopsis rosea	
Cypripedium calceolus	Yellow Lady's-Slipper
Cypripedium reginae	Showy Lady's-Slipper
Desmodium canadense	Canada Tick-Clover
Hepatica americana	
Iris prismatica	Slender Blue Flag
Lachnanthes tinctoria	Redroot
Lilium canadense	Canada Lily
Lophiola americana	Golden Crest
Panicum dichotomiflorum var. puritanorum	
Sabatia kennedyana	Plymouth Gentian
Selaginella rupestris	

An endangered plant is one which, under the prevailing circumstances, is likely to be extirpated throughout all or a significant portion of its range. Keddy (1969) dealt with the endangered wild plants of Nova Scotia in vegetation groupings. Most endangered plants are in the rich hardwood forest flora and the coastal plain flora, both of which are threatened by habitat destruction. A third floral element, the arctic-alpine, associated also with bogs and cliffs, contains several rare plants. However, these communities are not particularly threatened.

No specific plants are protected by law in Nova Scotia. The main conservation efforts have been directed towards the preservation of unique sites or exemplary areas of typical communities. The report of the International Biological Program, Conservation of Terrestrial Communities Sub-committee in Region 7 (Taschereau, 1976) identified 69 such sites in Nova Scotia. These and more recently identified sites may be protected by Special Places legislation (1980). Some measure of protection is offered to rare species which grow within the boundaries of federal, provincial and municipal parks.

Goldsmith (1977) has drawn attention to the need for more detail distributional studies on rare and endangered plants. A preliminary effort has been made by Isnor (1981) to present this information on the 10 km^2 grid system that has been used successfully in Britain and Europe. There is insufficient data on non-vascular plants to select the rare species although the algae are fairly well studied.

ASSOCIATED TOPICS

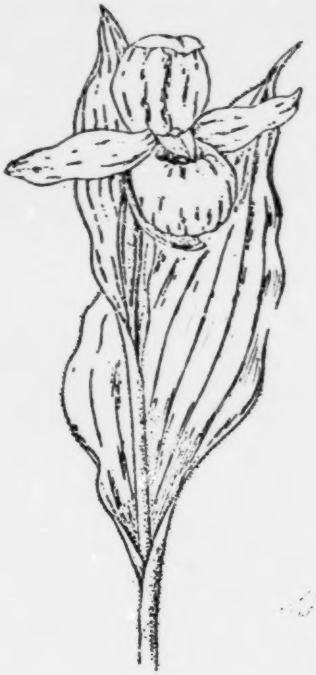
T16 Colonization by Plants, T40 Pteridophytes, T41 Seed-bearing Plants, T43 Plant Communities in Nova Scotia

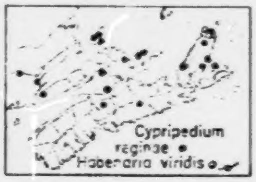
ASSOCIATED HABITATS

H15 to H16 Wetlands, H19 Cliff, H34 Sugar Maple, Elm (floodplain) forest

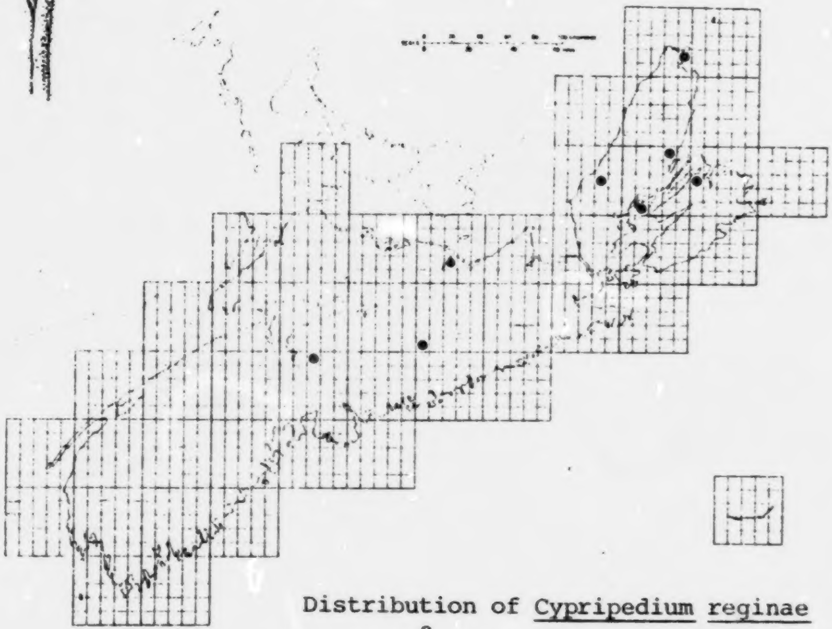
REFERENCES

Goldsmith (1977)
Isnor (1981)
Mahar _et al_ (1978)
Roland and Smith (1969)
Taschereau (1974)




Cypripedium
reginae ●
Habenaria viridis ●

Distribution of Cypripedium reginae
after Roland and Smith (1969)



Distribution of Cypripedium reginae
on 10 km^2 grid (after Isnor, 1981)

Fig. 61. Showy Lady's Slipper, Cyprepedium reginae, a rare plant in Nova Scotia.

ANIMALS

T48 Factors Influencing Avifauna

The composition of Nova Scotia's avifauna is influenced by the following factors:

Life Zones	Tufts recognizes two life zones in the province, based on climatic and forest features. The cooler and largely coniferous Canadian Zone is more likely to support nesting species typical of the boreal north, such as the Gray Jay, Spruce Grouse and Pine Grosbeak. The Transition Zone, in which lowland areas such as the Annapolis Valley (region 600) fall, is more temperate and typically supports more southerly species such as the Catbird, and Rose-breasted Grosbeak. This division is complicated by local climatic variations, due particularly to coastal influences, and by widespread forest disturbance. True boreal forest conditions are confined to northern Cape Breton (regions 100 and 200). Elsewhere habitats change over short distances, preventing the development of distinct regional avifaunas, although some agricultural areas support a quite distinctive avifauna.
Freshwater Environments	A large proportion of the Nova Scotia's surface is covered by water, but the oligotrophic or dystrophic nature of most lakes limits the productivity of the freshwater environments for wetland birds.
Shoreline Environments	Nova Scotia offers a range of coastal habitats for birds. The drowned shorelines along the Atlantic coast and the Northumberland Strait result in sheltered inlets, lagoons, eel grass flats, salt marshes and islands, while the large tidal range in the Bay of Fundy provides productive mud flats and salt marshes.
Chignecto Lowlands "Barrier'	The absence of certain species found at similar latitudes in Eastern Canada suggests that a "selective but undefined barrier" exists

	in the area of the Nova Scotia - New Brunswick border.
Migration Routes	Nova Scotia is positioned on the Atlantic flyway and is an important staging point for many birds migrating south.
"Exotic" Visitors	Because of Nova Scotia's prominent position on the Atlantic seaboard it is often the landfall for birds that are exhausted or have been blown off-course.

REFERENCES

See T49 Forest and Open Habitat Birds

T49 Forest and Open Habitat Birds

FOREST BIRDS

Habitat Factors

The densities of birds found in a given habitat are better correlated with the structure of the habitat than with the tree species, although these may strongly influence the actual bird species found there. In general an open habitat supports fewer birds than a forested habitat. The greatest densities are found where the greatest variety of feeding and sheltering niches are provided. Nova Scotia lies within a mixed forest region. Analysis of North American bird communities has shown that only five species have the centre and the majority of their ranges located in areas of mixed forest. Instead birds from the deciduous regions to the south and the coniferous regions to the north are in fact responding to the mixed forest as an ecotone. The result is a high bird species diversity.

Because of the degree of forest disturbance, edge and successional habitats abound in Nova Scotia. Little detailed information on these exists, but in general a mosaic of habitats supports higher densities than a large area of uniform habitat.

Vertical Zonation

In forest habitats a vertical zonation of foraging niches develops - ground, low shrub, subcanopy (tall shrubs and young trees), and upper canopy. Not all of these will be present in every habitat. To these horizontal layers can be added trunks and branches, and forest openings. Most breeding birds are insectivorous and depend on a well-stratified forest with good vertical diversity in order to segregate their feeding niches. Stratification is usually well developed in forests with trees of mixed ages. Mature forests offer additional niches in stumps, rotting trunks and openings caused by wind throws. Examples of the stratification features of some forest types are:

Pine (except Jack Pine)	dense upper canopy, lack of understorey.
Poplar	high concentration of shrubs, strong seasonal variations.
Spruce	extensive ground cover and low shrubs.
Climax Fir	wide range of height classes, strong regenerative growth.

Breeding Densities

General densities of breeding birds have been estimated for different habitat types. This list is not comprehensive because the study focussed on the boreal region.

	Pairs per square mile	Pairs per km^2
Jack Pine	200-500	80-200
Bogs	250-500	100-200
Open Habitats	400-1200	150-450
Spruce	500-1200	200-400
Balsam fir	800-1550	300-600
Maple/beech	1050-1700	400-650
Hemlock	1300-2100	500-800
Fir with extensive budworm infestation	1050-2100	400-800

Winter Survival

Approximately 80 percent of the boreal breeding species winter farther south. Birds that remain in winter may be either year-round residents, or winter residents or visitors migrating to Nova Scotia from the sub-Arctic. However, transient visitors such as the Brown Thrasher, and summer residents such as the American Robin and Common Grackle, are commonly found throughout the winter, especially in the southwest. Seeds and insects are the main food resources. Mixed woods offer opportunities for both food and shelter. Deciduous woods provide minimal cover. Diurnal birds using these habitats usually seek night-time cover elsewhere. In coniferous woods the upper canopy is the most used foraging niche. In winter the birds tend to form mixed species flocks, because such flocks are possibly more efficient at exploiting the available food resources. Many species utilize seed provided at bird feeders. The popularity of winter bird feeding is causing changes in the winter bird population.

Community Differentiation

Two bird communities are distinct if each population has at least 50 percent of its species characteristic for its particular habitat (Martin, 1960). When the differences fall below the 50 percent level the communities are considered merely different rather than distinct. In Kejimkujik Park it was found that the following habitats support a distinct bird community:

Deciduous forest	Red-eyed Vireo
	Ovenbird
	Least Flycatcher
	Northern Parula
	Veery
Boreal forest	Magnolia Warbler
	Ovenbird
	Yellow-rumped Warbler
	Hermit Thrush
	Nashville Warbler
Hemlock	Blackburnian Warbler
	Bay-breasted Warbler
	Black-throated Green Warbler
	Magnolia Warbler
	Swainson's Thrush
Bog	Common Yellowthroat
	Palm Warbler
	Swamp sparrow

Floodplain

- Red-winged Blackbird
- Common Grackle
- Tree Swallow
- American Bittern
- Yellow-bellied Sapsucker

Many more species will be found in each habitat. The birds listed are only those which show a definite preference.

Successional Habitats

Some studies have suggested that as a tract of forest moves through the various successional stages towards maturity there is an increase in bird species diversity. This does not however appear to be of general application. Other studies indicate no major differences in densities or diversity between uncut forest and early post-cutting successional forests, although all studies report major changes in species composition.

A recent study in a hardwood forest region in central Nova Scotia (Freedman *et al* 1981) showed the following change in species:

Uncut Hardwood Forests

- Least Flycatcher
- Hermit Thrush
- Solitary Vireo
- Black-and-white Warbler
- Northern Parula Warbler
- Black-throated Green Warbler
- Ovenbird
- Rose-breasted Grosbeak

Shrubby 3-5 year-old clear-cuts

- Ruby-throated Hummingbird
- Chestnut-sided Warbler
- Mourning Warbler
- Dark-eyed Junco
- White-throated Sparrow
- Song Sparrow

Certain birds are more likely to be found in mature forests, especially those that forage by probing in bark and dead wood, or nest in cavities - woodpeckers, chickadees, nuthatches and creepers.

OPEN HABITAT BIRDS

Habitat factors	Because open habitats, as for example fields or recent clear-cuts, provide little cover and few feeding niches, they do not support large populations of breeding birds. The densities and species composition of the birds using them will depend to a large degree on the surrounding habitat. Most birds frequent open habitats only to feed, as, for example, flocks of pre-migratory Goldfinches, Starlings or Cowbirds in late autumn, or hawks patrolling for prey. When the vegetation is dominated by grasses, graniverous birds will be most common. As shrubs and young trees grow up these will be replaced by insectivorous birds.
Agricultural areas	In the Annapolis Valley, and in other agricultural areas to a lesser extent, Pheasants, Mourning Doves, Cowbirds and Crows are found, because of the large areas of open habitat and the increased grain production in the area.

ASSOCIATED TOPICS

T48 Factors influencing Avifauna.

ASSOCIATED HABITATS

H17 Barren, H18 Oldfield, H22-34 Forested Habitats.

REFERENCES

Erskine (1977)
Freedman et al (1981)
Lunn (1973)
MacArthur (1971)
Martin (1960)
Rutherford (1983)
Tufts (1973)

T50 Birds of Prey

The birds of prey, collectively known as raptors, include the vultures, hawks, eagles, osprey and falcons (Falconiformes) and the owls (Strigiformes). All are carnivores or carrion feeders and are characterized by the possession of strong beaks and claws. The habits, and often large size of these birds have generated considerable public interest and there is a certain amount of folk-lore mixed with fact in popular knowledge about the group. All raptors are protected by law in Nova Scotia.

Food Supply

Hawks feed in the day time, mainly on small mammals, but also on reptiles, amphibians, small birds and insects. Early experience with hawks attacking farm poultry gave rise to the popular names "hen hawk" and "chicken hawk" being applied to hawks in general, perpetuating the tradition that hawks are harmful and should be considered a nuisance. Goshawks will frequently, and Red-tailed Hawks less frequently, take domestic fowl if the opportunity arises, while a number of other hawks will take grouse or small birds. The Bald Eagle and Osprey feed mainly on fish, the latter being an active fishing species. Carrion-feeding Turkey Vultures are not known to breed here but are seen now and again in summer and fall.

Owls hunt either at night (nocturnal) or in the twilight (crepuscular), mainly for small mammals. The Snowy Owl, an occasional visitor to Nova Scotia in winter, is diurnal in habit. Some hawks and owls generally prefer to hunt over open ground, and are commonly seen over fields. Others (Goshawk, Broad-winged Hawk, Sharp-shinned Hawk, Great Horned Owl, Saw Whet Owl, Barred Owl) more often hunt within the forest or along the forest edge. They consume large quantities of rodents and are thus considered to be of benefit to agriculture. The Barred Owl feeds on a wide variety of creatures, including snakes, eels, mice, rats, birds and insects.

Breeding

Raptors generally prefer nesting sites in remote areas to avoid disturbance, but nests are not unusual closer to human activities and habitation. The hawks commonly nest in high trees, often in old nests of crows, (particularly the Broad-winged Hawk and the Merlin). Osprey and Bald Eagle make large conspicuous nests which are built up each year. The Marsh Harrier is an exception as it builds its nest on the ground in wet grassland close to the marshland feeding habitat. Peregrine Falcons nest on the ledges of cliffs in preference to trees. Hawks usually lay their eggs during May. The owls are also largely tree nesting species. The Saw Whet and Barred Owls use holes in trees while the Great Horned Owl and Long-eared Owls use old nests of other birds or even dense growths of Witches Broom in spruce trees. Short-eared Owls nest on the ground. Eggs are laid between March and May and the young are hatched between April and June, depending upon the species.

Species Diversity

There are eleven species of hawks and eagles reported as breeding in Nova Scotia. Most are relatively common and have shown some increases in population since the 1960's. The Broad-winged Hawk breeds but is rare in summer, being most familiar as a fall migrant. Cooper's Hawk is recorded as breeding but is a rare bird in Nova Scotia. In addition there are seven other species which visit the province but which do not breed. This group includes the Rough-legged Hawk, which may be common during winter and some rare hawks, eagles and vultures. There are five species of owl that breed in Nova Scotia, the Great-horned Owl and Barred Owl perhaps being the most common. Four other species are common or rare visitors.

Distribution

Most of the hawks and owls that breed in Nova Scotia appear to be generally distributed but old remote forest stands provide the best nesting situations for many species. The Bald Eagle and Osprey occur close to their marine and fresh water feeding areas, particularly in northern Nova Scotia and along the Atlantic shore. The Marsh Harrier is characteristically found in marshland, mainly in the Bay of Fundy area. Eagle habitats have been mapped as part of the mapping of significant wildlife habitats by the provincial Department of Lands and Forests.

Human Factors

The false image, created in the past, that hawks are pests, led to the widespread and indiscriminate killing of these birds. However, this has largely, though not entirely, been remedied through education and legislation. The widespread use of insecticides and herbicides since the Second World War led to declines in raptor populations. The insecticide DDT is well documented as being an agent in this respect, through its effect on calcium metabolism and egg-shell thickness. Many species have shown recoveries since the withdrawal of DDT but other widely used chemicals still pose a threat.

Loss of habitat and disturbances of nesting areas by forestry, recreation and other activities are also problems.

The Peregrine Falcon, which has not bred in Nova Scotia since around 1960, is now being reintroduced to suitable habitats near Cape Chignecto (district 310).

ASSOCIATED HABITATS

H7 Saltmarsh, H8 Coast Fresh Marsh, H22-34 Forested Habitats

REFERENCES

Tufts (1973)
Nova Scotia Bird Society Checklist (no date).

T51 Wetland Birds and Waterfowl

Freshwater and coastal aquatic habitats are used not only by water birds, which obtain food from aquatic organisms, but also by many other birds which take advantage of the various forms of associated vegetation for feeding, resting or nesting. Because more is known about waterfowl (ducks and geese) they will be discussed separately.

WETLAND USERS

Acid Bog	The wetland most commonly found in Nova Scotia is the acid bog. This acidic, low oxygen environment does not provide good wildlife habitat, but it may be used by small passerines (perching birds) such as warblers and flycatchers for nesting if the structure of the vegetation is sufficiently developed. In a treeless bog birdlife is scarce. The bog community typically consists of a very few bird species, which may however reach high population levels.
Shrub Swamp	The second most common wetland is the shrub swamp, characterized by shrubs such as dogwoods, blueberry and viburnum. These are used primarily by nesting passerines. Cranberry bogs are used by geese in Cumberland and Shelburne Counties.
Wet Meadow	Seasonally flooded wet meadows, characterized by sedges, are used by several species of passerines for feeding. A few, such as the Red-winged Blackbird and the Swamp Sparrow, may also nest there.
Wooded Swamp	The hardwood wooded swamp, usually associated with floodplains, provides valuable breeding habitat for many larger birds, including herons, woodpeckers, hawks and owls. Coniferous wooded swamps provide habitats for warblers, nuthatches and kinglets.
Open	Open freshwater, which is almost always associated with other wetland types, is used by Loons and Cormorants for feeding and resting,

and as feeding areas for fish-eating raptors and gulls.

Deep and Shallow Marsh

Although comparatively uncommon in Nova Scotia deep and shallow marshes provide very valuable habitat for waterfowl and many other water birds, such as Loons, herons, and Bitterns. Shrubs on the fringe of the marsh will also support a community of small passerines, such as Redwings and Cedar Waxwings.

WATERFOWL

Waterfowl may be divided into four broad categories: year-round residents, summer residents that breed here but winter farther south, winter residents that breed to the north or west of Nova Scotia, and transients, building up their energy reserves to continue their flight. In summer water birds are found on inland and coastal waters, but in winter they are confined to tidal waters and a few large lakes and fast flowing streams which remain unfrozen.

Inland Habitat Factors

Some major factors influencing inland habitats for waterfowl include:

a) Shoreline gradient: a shallow-sloping shore line permits extensive marsh development, providing feeding and cover opportunities.
b) Water level variability: springtime flooding can damage nests, other ponds may dry up in the summer.
c) Fertility: insufficient nutrients in the soil and/or water inhibit the growth of vegetation and aquatic insect habitat necessary for waterfowl production.
d) Shoreline development: a lake with islands and a highly indented shoreline provides better habit than a similar size lake with a regular shoreline.
e) Ice cover
f) Soil and water characteristics: excessive salinity or acidity, or other chemical factors can inhibit the growth of plant and animal communities on which waterfowl depend.
g) Disturbance
h) Interspersion and juxtaposition of vegetation.

Coastal Habitat Factors

Coastal habitat factors include:

a) Degree of exposure: with the exception of a few species like Harlequin Duck, waterfowl are usually found in sheltered areas.
b) Ice cover: for winter residents and spring transients ice cover is an important factor. This is partly why the southwest tip of Nova Scotia attracts large numbers of waterfowl.
c) Coastal marsh and eelgrass bed development.
d) Islands: while most waterfowl prefer sheltered estuarine conditions the Common Eider nests on rugged, offshore islands.

Inland Distribution

The largest area of productive waterfowl habitat is the basically man-made system of freshwater marshes in the Chignecto lowlands near Amherst (unit 523). Other areas include the larger floodplain rivers such as the Musquodoboit and Stewiacke (district 510), and agricultural areas where there are nutrient inputs. In each case the basin drained by the river contains somewhat more fertile soils than in much of the province. In general the river systems which drain over areas of softer and more basic sedimentary rock often have more capacity to support waterfowl. Examples, all of which are in region 500, include the Shubenacadie, the Stewiacke, the Kennetcook, the Salmon River in Colchester County, and the Margaree.

Coastal Distribution

Eastern Shore: Substantial numbers of migrating waterfowl use the sheltered inlets, salt marshes and Eel Grass beds along this coast from Halifax to New Harbour (units 834 and 842). The islands (unit 834) constitute the major portion of the Common Eider's breeding and brood rearing habitat in Nova Scotia. Wintering species are sparsely distributed, except in the major coastal marshes which occur at Cole Harbour, Chezzetcook,Petpeswick Inlet, Martinique Beach, Musquodoboit Harbour and Clam Bay and are important habitat for Black Duck and Canada Geese (unit 833).

South Shore: From Halifax to Liverpool (units 851 and 832) the coast is rocky with minimal marsh development and low numbers of waterfowl. South of Liverpool, in units 841 and 831, coastal marshes and Eel Grass beds are more common, supporting waterfowl through fall, winter and early spring. Port Joli, Port Hebert and Sable River are important areas. The coast around Yarmouth (unit 831), where the tidal range begins to increase, is characterized by extensive mud flats, numerous islands and salt marshes and large beds of eel grass. Because of the abundant food resources and the mild climate it is an important wintering area.

Bay of Fundy: Productive areas include St. Mary's Bay, which is favoured by the Common Eider in winter, the Annapolis Basin which has a wide variety of wintering waterfowl, and the Cornwallis and Avon estuaries. The Salmon River estuary is important habitat for Black Duck. The marshes at the head of Chignecto Bay provide valuable feeding grounds during spring and fall migration. The Shubenacadie estuary provides habitat for mergansers. In general, the Bay of Fundy has become in the last twenty years a significant wintering area for Black Duck.

Northumberland Strait (district 520): Embayments along this drowned shoreline provide shelter and tidal flats, with a large salt marsh in Wallace Bay. Waterfowl are found in Fox Harbour, Wallace Harbour, Tatamagouche Bay, Brule Harbour, John Bay, Bay Verte, Northport and Merigomish Harbour from March to April and again from September to December, but severe icing conditions preclude winter residence except in the Antigonish area. Black ducks winter in Antigonish and Pomquet Harbours.

Cape Breton: Except for small pockets Cape Breton does not provide very productive waterfowl habitat. The northern coastline is rocky and precipitous with few estuaries. The southeastern coast has little salt marsh development - a combination of low sediment supply and cold water influence.

ASSOCIATED TOPICS

T29-30 Surface Waters

ASSOCIATED HABITATS

H7 Saltmarsh, H8 Coastal Fresh Marsh, H10-16 Freshwater Habitats

REFERENCES

Canadian Wildlife Service (1976)
Canada Land Inventory (1970)
Lunn (1972)
Tufts (1973)

T52 Shorebirds

Most of the shorebirds seen in Nova Scotia breed in the Arctic and migrate to South America and the southern United States to spend the winter. Nova Scotia is an important area for shorebirds for two reasons: 1) it is the last large land mass on the flyway south for many species, and 2) it can provide extensive intertidal feeding areas where birds can build their fat supplies in preparation for the journey ahead.

Food Supply	Most shorebirds feed in the intertidal zone on benthic infauna. The largest concentrations of birds are found where large tidal amplitudes result in extensive intertidal areas in the Bay of Fundy. Salt marsh development is also important, not so much for direct feeding but for the export of nutrients on which the invertebrate populations depend.
Roosting Sites	At high tide, when shorebirds can no longer feed, they require roosting sites nearby. Sand and gravel beaches or marshes are favoured, although some species like the Short-billed Dowitcher and the American Golden Plover will also fly inland to roost on ploughed fields.
Winter Ranges	North American shorebirds can be divided into two groups according to their winter distribution. The first group, including species such as the Knot, the White-rumped Sandpiper and Hudsonian Godwit winter in the southern temperate latitudes of South America, and can apparently reach the north eastern coast of South America by direct non-stop oceanic flight from the Atlantic Provinces or the New England states. The second group includes the Greater Yellowlegs, Lesser Yellowlegs, Least Sandpiper, Short-billed Dowitcher and Semi-palmated Sandpiper. These are widely distributed in winter from the southern United States to South America. The fattest individual birds in fall are able to migrate by an oversea non-stop flight and can penetrate further south. The leaner birds must migrate coastally or through the interior of the U.S.

Migration Routes

For most species the fall migration route differs from that used in spring. This is indicated by the fact that the numbers of shorebirds found on the Canadian Atlantic coast and in northeastern Venezuela are greater in the fall than in the spring. It appears that clockwise elliptical routes have developed in both directions as an adaptation to the prevailing westerly and easterly winds. The difference in the nature of the fall and spring routes is reflected in the amount of energy the birds must store. The more gruelling oceanic fall route demands greater flight-range capability and therefore the accumulation of greater fat reserves.

DISTRIBUTION IN NOVA SCOTIA

Upper Bay of Fundy

By far the greatest numbers of shorebirds are found in the upper Bay of Fundy, where enormous areas of mudflats are exposed. More birds are seen in Chignecto Bay and Cumberland Basin (unit 523) than in Minas Basin and Cobequid Bay (district 620). The reasons may be partly geographical. Birds arriving from the north would tend to occupy the northwest arm of the Bay of Fundy first. But it may also be that the more extensive salt marshes in that area enrich the food resources provided by the mudflats.

A special feature of this area is the enormous flocks of semi-palmated sandpipers which congregate from mid July to late August, particularly on the shores of the Minas Basin. They are uncommon in spring.

Brier Island

Brier Island (district 810) is another outstanding area for shorebirds. Tens of thousands of Red Phalaropes gather during autumn migration, taking advantage of the large amounts of food brought to the surface by highly localised upwellings. Considerable numbers of Purple sandpipers also spend the winter on the island and elsewhere.

Yarmouth to Cape Sable

The coastline between Yarmouth and Cape Sable (unit 831) contains a number of estuarine "harbours" and inlets with wide expanses of mudflats and saltmarshes. This area is used

	extensively by Ruddy Turnstones, Short-billed Dowitchers, Sandpipers and Sanderling. Comparatively high breeding densities of Willets are also found here.
Cape Sable to Halifax	The coastline from Cape Sable to Halifax varies and shorebird distribution is uneven. The tidal range is low, but long inlets with barrier beaches and lagoons do occur. While the densities of shorebirds are low, the diversity is high.
Halifax to Canso	Shorebirds are locally common around shores of shallow water bogs and estuaries from Halifax to Clam Harbour (unit 833), but occur in very low numbers from there to Canso.
Cape Breton Island	Migratory shorebirds may be locally numerous in Big Glace Bay Lake Sanctuary and Dominion Beach in unit 531 and at Framboise and Belfry Lake in district 870 and other barrier beach ponds and coastal lagoons. Whimbrels are present on barren headlands and coastal islands in late summer and fall.

ASSOCIATED HABITATS

H3-H7 Inter-tidal Habitats, H8 Coastal Freshmarsh

REFERENCES

McNeil and Cadieux (1972)
Morrison (1974)

T53 Seabirds

The term "seabird" is here used to denote birds that obtain a substantial proportion of their food from coastal or open waters. A seabird may use the land for feeding and resting at certain times, or may be entirely independant of the land except for breeding.

Food Supply

The waters off the coast of Nova Scotia fall within the boreal oceanic zone in which fish form the primary food source of most seabird species. Spatial and temporal variations in the abundance of fish, particularly herrings, eels, cod and capelin, are major determinants of the breeding seasons, the breeding sites, and the movements of seabirds. These variations are in turn dependant on such factors as ocean currents, seasonal phytoplankton blooms, localized upwellings, and the presence of fishing boats.

Breeding

The breeding season stretches from March to September. Seabirds differ from other birds in that they cannot breed on their feeding grounds. The distribution of seabirds during the breeding season is therefore a compromise between oceanographic conditions, suitable food supplies, and suitable breeding sites. Climate is also a factor. An area must have a summer long enough for the birds to fit in a successful breeding season.

Breeding colonies are very vulnerable to predation. For this reason many breeding sites are located on offshore islands, which are numerous along the Atlantic coast, particularly where there are drowned drumlin fields (district 830). Cliff nesting sites provide protection from ground and aerial predators. High, stable cliffs are limited to northern Cape Breton (district 210), with lower, eroding cliffs on the Northumberland Strait and the Bay of Fundy. Figure 62 shows the location of seabird colonies for selected species.

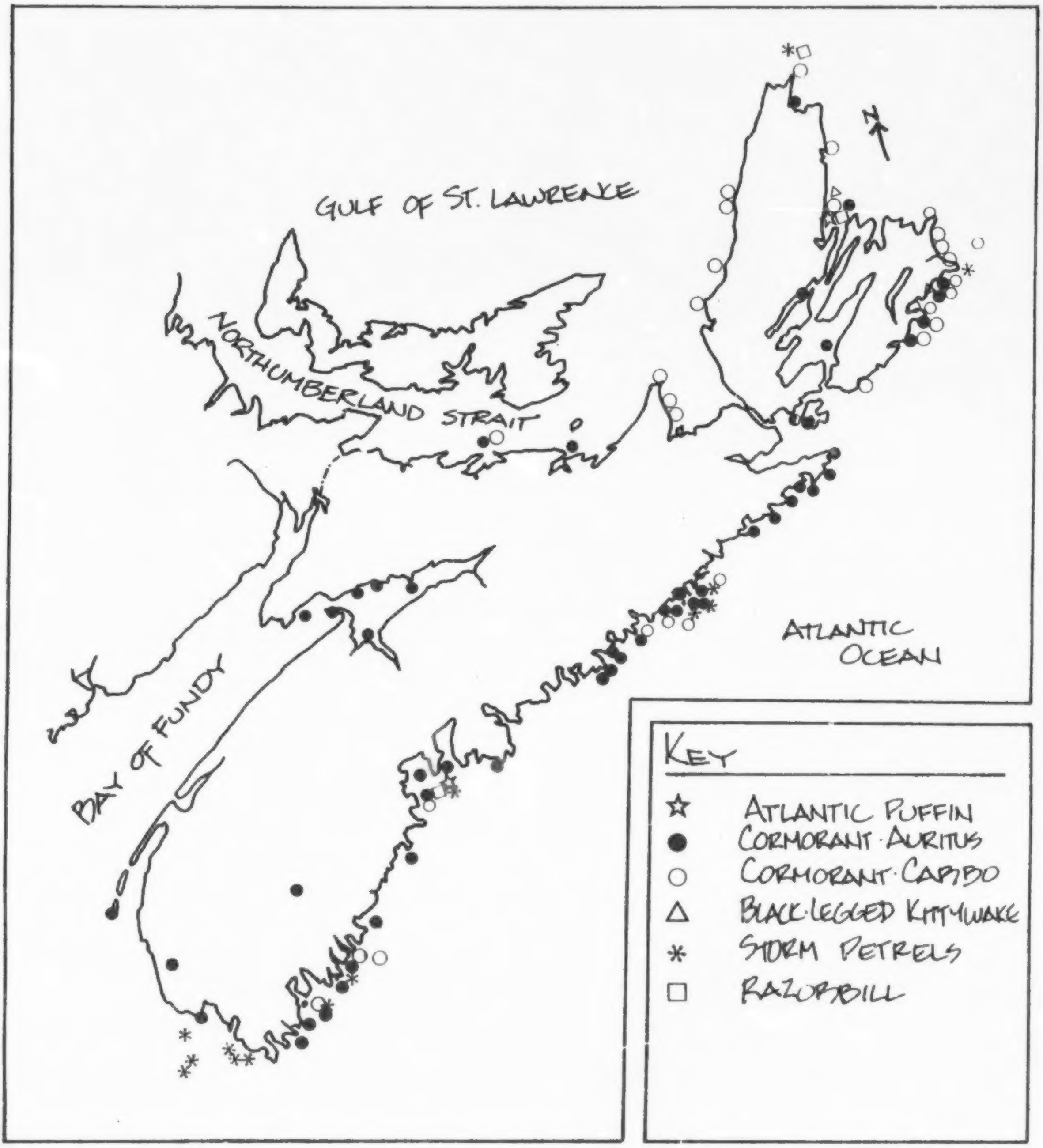

GULF OF ST. LAWRENCE
NORTHUMBERLAND STRAIT
BAY OF FUNDY
ATLANTIC OCEAN
N
KEY
☆ ATLANTIC PUFFIN
● CORMORANT · AURITUS
○ CORMORANT · CARBO
△ BLACK-LEGGED KITTIWAKE
* STORM PETRELS
□ RAZORBILL

Fig. 62. Some Seabird Colonies of Selected Species, Nova Scotia. Brown *et al* (1975)

Human Factors

Two examples of the effects of human activity on seabird populations and distribution are:

a) Disturbance and human predation - the best documented case being the extinction of one and near-extinction of another large gannet colony in the Gulf of St. Lawrence, and of two colonies in the Bay of Fundy.

b) Garbage as food supplies: Herring Gull colonies have expanded dramatically in recent years because of their ability to exploit human garbage. This expansion is to the detriment of other species on which they prey.

Species

The waters off Nova Scotia lie within the Boreal range. Eleven species of seabird breed in Nova Scotia, but sightings of another eighteen species are regularly reported. Most of these visitors are from the Low and High Arctic Zones, but some, like the Shearwaters, migrate up from warmer regions in the south.

The Wilson's Storm Petrel, which is fairly common in the Boreal zone, actually breeds in the Antarctic. All come to take advantage of seasonal fish runs or zooplankton abundance.

Distribution

Seabirds are seen less frequently in the upper reaches of the Bay of Fundy and in the southern part of the Gulf of St. Lawrence. Gannets are one exception to this rule in the Gulf, but their numbers have been reduced by human disturbance. The low numbers of seabirds in these areas may be attributed to the lack of suitable nesting sites and, in the Gulf, severe ice conditions in winter. Figure 63 shows areas where large and medium concentrations of seabirds occur on open waters, reflecting localized upwellings of southwest Nova Scotia and Cape Breton (district 870), and the swarms of euphausiids and sardines in the Bay of Fundy.

ASSOCIATED TOPICS

T23 Oceanographic Environments, T61 Marine Fishes, T63 Marine Invertebrates

ASSOCIATED HABITATS

H2 Open Water, H19 Cliff

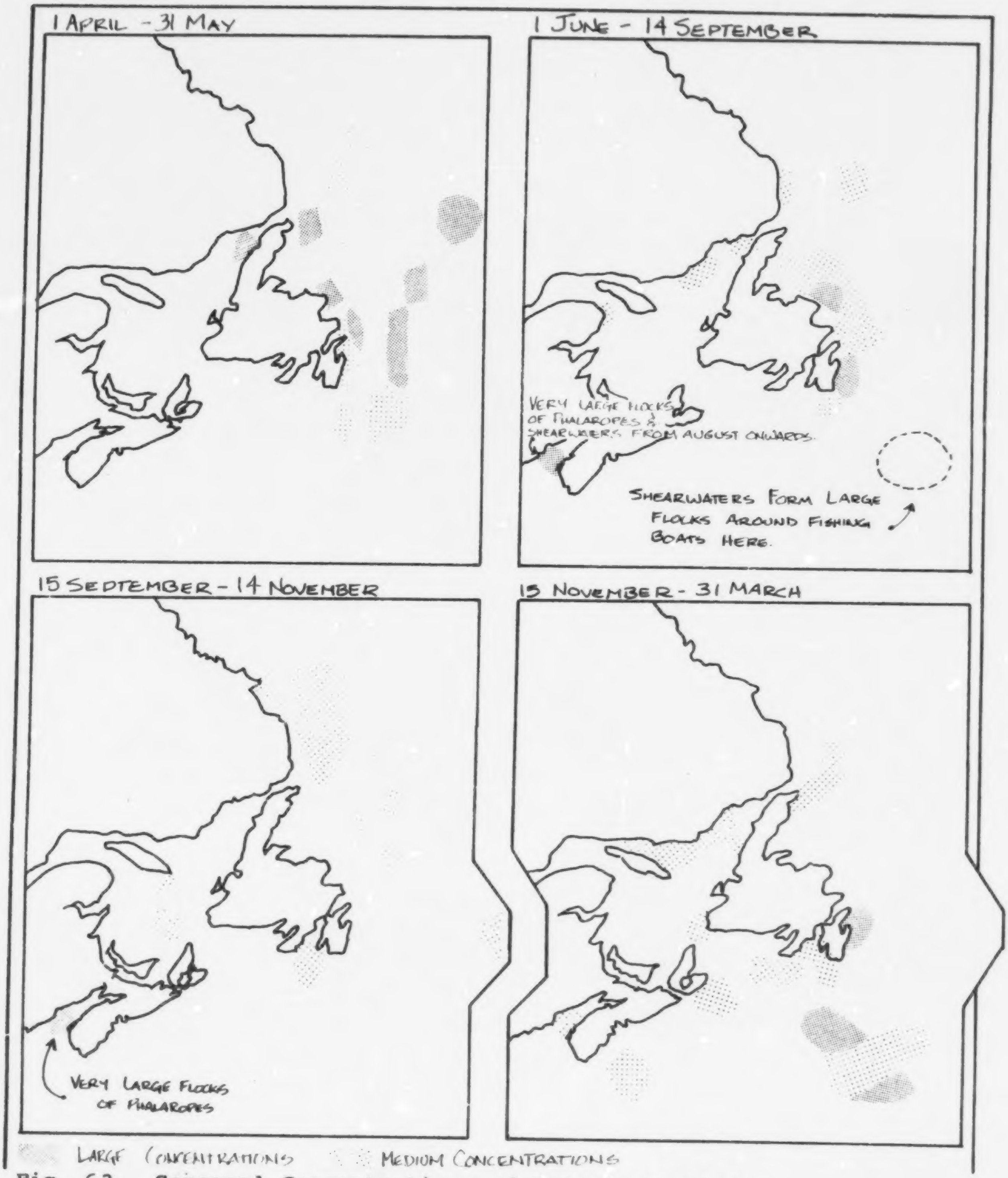

1 April - 31 May
1 June - 14 September
Very large flocks of Phalaropes & Shearwaters from August onwards.
Shearwaters form large flocks around fishing boats here.
15 September - 14 November
Very large flocks of Phalaropes
15 November - 31 March
Large Concentrations
Medium Concentrations

Fig. 63. Seasonal Concentrations of Pelagic Seabirds. Brown et al (1975)

REFERENCES

Ashmole (1971)
Brown (1975)
Erskine (1972)

T54 Mammals

Species

A total of fifty-four mammal species have been recorded in Nova Scotia. Of these, four - the caribou, wolf, Sea Mink and the introduced Black Rat - are now extinct. Two species, the Grey Squirrel and the cougar, are considered to be indefinite because of the limited evidence of their presence. The Norway Rat and house mouse are recent introductions, while the Fisher has been reintroduced. The mammal fauna of Nova Scotia includes fewer species than are found, for example, in southern Ontario. This is because a number of central continental species which occupy habitats similar to those in Nova Scotia have not yet penetrated this far north and east. This difference is generally more pronounced in the diversity of small mammals which are less mobile and are constrained by tighter habitat restrictions than the larger, more mobile mammals.

The composition and distribution of the mammal fauna in Nova Scotia is influenced by a number of factors.

1) Climatic change and colonization routes
2) Life zones
3) Variety of available environments
4) Natural barriers
5) Introductions and extinctions, and the impacts of human settlement.

Colonization

The existing mammal fauna populated Nova Scotia after the last retreat of the ice sheet by four different routes

1) moving in from the glacial refugium on what is now the continental shelf
2) moving in from unglaciated areas on the coastal side of the Appalachians via the Chignecto landbridge (unit 533)
3) over sea by swimming, rafting on ice, or crossing ice bridges
4) by human introduction

Of these four routes the landbridge was the major entry point for the largest number of species. Thus the interaction between the relative mobility of different species and the shifting of climatic zones in relation to the position of the landbridge is significant. As the ice retreated the first animals to appear would be those with more northerly affinities. Certain southern species such as the porcupine, raccoon, skunk and woodchuck have arrived comparatively recently.

Life zones

Nova Scotia lies within the Canadian Biotic Province which includes New England, southern Quebec, southern Ontario and parts of the western Great Lakes. Nova Scotia can be subdivided into two life zones. The Atlantic Upland (regions 100, 200, 300, 400 and 800) is cool and humid with many conifers and bogs. Here the characteristic species include hare, lynx, Red Squirrel, moose, marten, beaver and Deer Mouse. The Acadian Plain (regions 500, 600 and 700) is low, fertile, flat, and well drained with large agricultural areas. It is sometimes included in the Alleghanian Life Zone, which is in turn part of the more southerly Austral Region. Here the characteristic species include raccoon, skunk, deer, the Short-tailed Shrew, White-footed Mouse and Arctic Shrew. Beyond this broad division it is not easy to delineate distinct regional fauna, although certain species like the White-footed Mouse do show a marked regional distribution. In general however, mammals are too mobile and habitats in the province too widely distributed for distinct mammal regions to develop.

Environments

Nova Scotia encompasses a variety of terrestrial and aquatic environments for mammals including forests, wetlands, agricultural areas, mountains, valleys and seashores. Browsing animals thrive in areas of new hardwood and shrub growth associated with early successional forests in disturbed areas. Others, like the marten and fisher, require climax vegetation. Certain species favour more open areas and edge habitats, like the fox and the raccoon. Others, like the lynx, need large areas of wildland remote from human presence.

Natural barriers

A large expanse of water presents a very definite barrier to the distribution of mammals. Cape Breton, until very recently, was an island separated from the mainland by the Strait of Canso, over a mile in width. Nevertheless, when compared to other islands in the Gulf of St. Lawrence, Cape Breton has a relatively rich mammal fauna. Only five of the mainland Nova Scotia species are missing: the Porcupine, Skunk, Arctic Shrew, Smoky Shrew and White-footed Mouse. The raccoon was also originally missing but has been recently introduced. The islands which are more isolated, Newfoundland, Magdalen, and Anticosti, only have approximately half the species found on the adjacent mainland.

It is highly probable that Cape Breton had a land connection to the mainland within the last 12,000 years. This theory is reinforced by the presence of native mice and shrews on Cape Breton. These small animals would have had little chance of making the crossing safely on an ice raft. Several of the missing species were comparative latecomers to the region and would have therefore been too late to take advantage of the land bridge. The raccoon, for example, only reached northern New Brunswick in the last century. Now that a causeway is in place a solid ice bridge regularly forms between Cape Breton and the mainland which no doubt assists the movement of larger mammals in both directions. No insular races of mammals have developed on Cape Breton. The moose is a different subspecies but only because some moose from the western provinces were released on the island after the native subspecies had almost become extinct in the 1940's.

The barriers to the colonization of Sable Island (region 900) are obviously more formidable. Only marine mammals are native to the island, which they share with the horses.

Introductions and Extinctions

Four rodent species were introduced, three of them presumably inadvertently. The Black Rat subsequently failed to compete successfully with the Norway Rat and has since become extinct. Grey Squirrels were deliberately introduced to southwest Nova Scotia in the 1930's, but became extinct within a few years.

Attempts were made to reintroduce caribou in the Liscomb (district 410) area in 1939 and in Cape Breton in 1968 and 1969 (region 100), but without success. More success attended the release of fishers in various parts of the mainland in the 1940's and again in the 1960's. The Arctic Hare has also been introduced on Scatarie Island (district 870). The newest mammal to appear in Nova Scotia, although not a deliberate introduction, is the coyote. The coyote originally had an exclusively western distribution, but in the 1900's for reasons that are not wholly clear it began moving eastwards. Sightings in Nova Scotia have now been recorded as far south as Digby and Yarmouth Counties.

Three native species are now extinct. Little is known about the Sea Mink except that it used to be trapped for food and fur in the Bay of Fundy. The last specimen was taken in 1894 at Campobello Island. Hunting pressures were probably the main factor in extermination. The wolf was probably never common in Nova Scotia and would have faced determined human opposition. The caribou were forced out by climatic changes and habitat destruction.

General Requirements

The two most important requirements for mammals are food and cover.

Many mammals will perforce eat a wide variety of foods, although they have preferred food sources. Food sources for the insectivores and very small herbivores are linked to soil productivity and the diversity of ground vegetation. These mammals are therefore most abundant in the more productive habitats such as hardwood forests and floodplains, and more depleted in the less productive habitats, such as jack pine stands and barrens. In the case of carnivores this link still exists, but is less direct. The largest carnivores, which eat higher on the food chain and do not need to eat as frequently as smaller animals, are more mobile. Therefore they are not necessarily confined at all times to habitats which contain a suitable food supply.

Cover provides shelter from extreme environmental conditions, concealment from predators, and a secure place to rest, sleep, or raise young. Snow accumulation is an important factor. Deer often winter at lower elevations or near the coast where snowfall will be less, thus enabling them to move about and to feed close to the ground. Many small mammals, on the other hand, rely on persistent snow cover over leaf litter for their winter shelter.

Population Fluctuations

The populations of some animals, such as the Snowshoe Hare, the muskrat and several species of mice, show marked fluctuations on a regular cycle. Thus their numbers can vary considerably from year to year. These fluctuations often appear to be synchronised over a large area and therefore do not relate to short-term weather or habitat quality changes. The cycles will also affect certain other species which are heavily dependant on one item in their diet. Numbers of lynx for example reflect the abundance of Snowshoe Hare, while the bobcat, which has a more varied diet, is less affected.

ASSOCIATED TOPICS

T17 Colonization by Animals

REFERENCES

See T57 Carnivores

T55 Small Mammals

In this context small mammals include bats, rodents, hares and insectivores. They form an important part of the terrestrial food web by eating large amounts of seeds, plants and insects, and then themselves becoming a vital food resource for larger predators.

Shrews, Moles and Small Rodents

Most small mammal populations undergo drastic fluctuations, and may determine the levels of predatory species such as the fox, weasel and some hawks. Typically the smaller mammals like shrews have very demanding metabolisms which require large and constant energy inputs. They are therefore closely confined to habitats which provide ample and accessible food. Some like the Cinereus Shrew or the Water Shrew are associated with open water or high levels of soil moisture. A thick litter layer is often an important factor, allowing small animals to make runways and stay mobile under snow cover in winter. In Nova Scotia few small mammals are true hibernators, and they are therefore vulnerable to severe winter conditions, especially extreme low temperatures with little or no snow cover.

Common and widespread small mammals include the Cinereus Shrew, the Short-tailed Shrew, Red-backed Vole, Meadow Vole (numbers of which sometimes reach plague proportions) and the Woodland Jumping Mouse. Five species of the squirrel family are present in Nova Scotia. Two are ground squirrels - the chipmunk and woodchuck.

Several species are disjunct meaning that there is a gap between their range elsewhere and their occurence in Nova Scotia. These include the Gaspe Shrew, the Arctic Shrew, the Rock Vole and the White-footed Mouse, all of which have more northerly distributions. The Southern Flying Squirrel has more southern affinities and is so far only known to exist in a pocket around the Kejimkujik area which has very warm summer temperatures.

Bats

Only one species of bat, the Little Brown Bat, is common throughout the province. Another five species are uncommon or rare. Three species hibernate in Nova Scotia, while the other three are migratory. Hibernation requires a stable temperature and humidity regime and security from disturbance. Caves and abandoned mines are usually selected. Hayes Cave in Hants County (district 510), 3 miles (4.5 km) west-southwest of South Maitland, is the only known large hibernaculum in Nova Scotia at present. In winter it is occupied by between 3,700 and 6,300 bats. Miller's Creek Cave, also in Hants County, was used by about 6,000 bats prior to the early 1970's when gypsum quarrying operations caused it to be abandoned.

Hares

Two hares are found in Nova Scotia, the Snowshoe or Varying Hare and the Arctic hare. Like moose and deer the Snowshoe Hare is a browsing animal, eating herbaceous material in summer and woody material in winter. They favour mid to late successional stages of mixed forests, dense alder thickets and softwood swamps. Population cycles occur every 8-10 years. The Arctic Hare, which has been reintroduced on Scatarie Island (district 870), is larger and can withstand colder winters.

Larger rodents

The beaver and muskrat are both largely aquatic. The beaver is associated with deciduous trees, especially aspen, in upland areas, while the muskrat favours freshwater swamps and cattail marshes in lowland areas, and also tidal creeks. For both species water levels are an important factor as dramatic rises especially in spring can wash out dens and drown the young. Beavers are found throughout the province although population densities are not as high in western Nova Scotia because the habitat is inferior. The beaver was actually threatened by extermination at the end of the nineteenth century, but numbers rebounded after the trapping season was closed. Muskrats are most common in the Carboniferous Lowland region (500). The porcupine is a comparative latecomer to Nova Scotia. It prefers hemlock, pine and second growth birch and poplar.

ASSOCIATED HABITATS

H17-34 Terrestrial Habitats

REFERENCES

See T57 Carnivores

T56 Ungulates

Range

Three species of ungulate have at one time inhabited Nova Scotia, and their respective fortunes illustrate the effects of long term climatic change, habitat alteration and hunting pressures. The caribou is the most northerly species with a range extending high into the Arctic. The caribou is an animal of the tundra and the true boreal forest. The range of the moose substantially overlaps that of the caribou but is restricted to the forested regions and reaches farther south. The White-tailed Deer has a much more southerly range, extending well down into South America. Habitat requirements also show a successional gradation through the three species. Woodland caribou primarily eat lichens associated with the climax forest. Moose prefer sub-climax vegetation with shrubby growth, while deer thrive on early successional stage vegetation associated with cut-over or burned land and abandoned farm land.

Climatic Change

Archeological evidence (the contents of Indian midden heaps) suggests that deer were present in Nova Scotia long before the first European settlers arrived. This would be consistent with the warming trend after the Wisconsin glaciation. As the climate started to cool deer populations diminished and the caribou became more firmly established. By the time the first white settlers appeared the last deer had probably gone, but a new warming trend was beginning to decrease caribou numbers. Caribou were affected not only by climatic change but also by widespread hunting and by the destruction of the climax forests by cutting and, particularly in southwestern Nova Scotia, by fire which killed tree and ground lichens. Caribou are migratory and apparently moved from the Cobequids to winter in southwestern Nova Scotia. Lichens grow very slowly and once burned they may take 80-100 years to re-establish themselves. Caribou were extinct on the mainland by 1905 and in Cape Breton by 1912.

The Arrival of Deer

The destruction of the caribou range and the subsequent new shrub growth benefited moose, but they were also very vulnerable to hunting pressures particularly in winters of deep snow. Moose numbers thus fluctuated with changes in hunting legislation. The forest disturbance and gradual warming trends favoured deer even more and they started to reappear in the 1890's, both through deliberate introductions and by moving in from New Brunswick. Before European settlement deer were only plentiful in North America where natural fire and windfalls created forest openings. After settlement the distribution pattern showed a boom in deer numbers on the northern lumbering frontier and a decline in southern areas as permanent agriculture became entrenched. Deer populations in Nova Scotia followed this trend with rapid expansion occurring 1945-55 following the widespread abandonment of farm lands during the Depression years. After the second world war deer habitat started to deteriorate. Agriculture became more intensive, small fuelwood cuts were superceded by softwood clearcutting and fires were controlled.

Moose Sickness

The effects of land clearing resulted in a greater overlap of deer and moose ranges. In the 1940's it became evident that moose were dying in large numbers of a mysterious disease labelled "moose sickness". Moose appeared to prosper only in those areas where deer were not abundant. It was not until 1964 that the cause of moose sickness was identified as a nematode parasite, *Parelaphostrongylus tenuis*, carried by, but not harmful to, deer.

Unsuccessful attempts were made to reintroduce caribou in Liscomb in 1938 and in Cape Breton in 1968 and 1969. It was however apparent that climatic and habitat conditions no longer favoured caribou presence. Caribou were also susceptible to moose sickness. Moose numbers fluctuated with the changes in hunting legislation and moose all but disappeared from Cape Breton. Attempts to reintroduce individuals from the mainland did not appear to help but in 1947 and 1948 eighteen Alberta moose were released with more success. Moose in Cape Breton today belong to the western subspecies Alces alce andersoni, while mainland moose are A.a. americana.

Habitat and Food Factors

Moose and deer eat herbaceous vegetation in the summer and switch to woody browse in winter. Moose also like to eat aquatic plants, although not an indispensable item in their diet. Favoured deer browse includes Red Maple, White Birch, Sugar Maple, Yellow Birch, Mountain and Striped Maple. Moose particularly favour White Birch stands. Both species have benefited from the depredations of the Spruce Budworm, where this has been followed by accelerated harvesting, which in turn promotes new growth, although the increase in hardwood browse may eventually be outweighed by the decrease in cover.

Winter

Because they are southerly animals deer are more stressed by hard winters than moose. Deer feed close to the ground for as long as possible, but they always have to balance their food requirements with the need for winter cover. Long periods of deep snow force them to congregate together in deer yards where suitable hardwood browse is often unavailable in conjunction with softwood shelter. Moose will also yard in hard winters but usually at higher elevations. Orientation is important because south and southwest slopes offer a more favourable microclimate. Because the shelter requirements of moose are not as stringent they are usually able to select areas with higher food resources.

At present, moose appear to be increasing in numbers, particularly in western Nova Scotia and Cape Breton. In very recent years deer populations also appear to be growing.

ASSOCIATED HABITATS

H18 Oldfield, H22-34 Forested Habitats

REFERENCES

See T57 Carnivores

T57 Carnivores

The mammals of this group are primarily flesh eaters but some, like the bear and raccoon, are omnivorous. Twelve species of carnivore are now present in Nova Scotia.

Dog family

The Red Fox and the recently arrived coyote are the only members of this family in Nova Scotia. The earlier presence of the wolf was probably marginal, perhaps only amounting to the occasional incursion from New Brunswick. Arctic Foxes frequent southward drifting ice floes off the Labrador coast and in 1923 and 1935 there were records of Arctic Foxes reaching Cape Breton. Red Foxes prefer semi-open country and are seldom found in dense forest. They are often associated with agricultural land.

Cat Family

Two members of this family, the bobcat and lynx are definitely found in Nova Scotia, while circumstantial evidence indicating the presence of a third member, the cougar, is rapidly accumulating. The bobcat, a more southerly animal than the lynx, is widely distributed throughout the mainland, but uncommon in Cape Breton and the northern part of the mainland.

Snowshoe hare is an important part of the diet of both species, although the bobcat is somewhat less dependant on it. In other parts of the country a relationship between the population cycles of the hare and the lynx has been observed, but this has not been well documented in Nova Scotia. The lynx prefers dense climax boreal forest with a dense undercover of thickets and windfalls, while the bobcat will frequent a much wider range of habitats including swamps, second-growth forest, and even agricultural land.

The cougar is a much larger animal than either of the other cats, and requires large areas of unpopulated forest land. It is estimated that the home range of cougar is often in excess of 35 square miles (90 km^2). Sightings, fresh tracks and cougar screams have been reported but as yet no cougar has been photographed, trapped or shot.

Bear and Raccoon

Although a member of the carnivore order, the Black Bear's diet is 75 percent vegetable matter. It is widely scattered throughout the province but more numerous in the five western counties. Bears range widely over a variety of habitats, and often move on to barrens in the summer to forage for berries. The raccoon is a member of the family Procyonidae, which also includes the panda. The raccoon is a southerly animal and a recent arrival in Nova Scotia. Raccoons are usually found in forested lowland areas near water courses, wooded coastline and salt marsh. They are also often associated with agricultural land, especially in the Annapolis Valley (district 610). They have only recently become established in Cape Breton after being introduced illegally from one of the eastern United States.

Mustelids

Six species of mustelids (weasels and their allies) occur in Nova Scotia. The mink and otter are semi-aquatic mammals found in streams, lakes, marshes and at the seashore. The ermine uses a wide variety of wooded habitats. All three are common in Nova Scotia. The Pine Marten and fisher are both creatures of the mature forest. The marten is more or less confined to mature coniferous woods while the fisher will venture into deciduous forest. Both have faced drastic decline in numbers due to habitat destruction by cutting and fire. The remnant marten population has retreated to the few remaining climax forest areas in Cape Breton. The fisher probably disappeared from Nova Scotia early in this century, but was reintroduced and appears to have adapted somewhat better than the marten to second growth forests.

The Striped Skunk is a southerly animal which is believed to have spread into Nova Scotia since 1850. Its numbers declined after 1930, probably due to disease introduced by skunk farming, until the skunk was almost extinct. Since then skunks have re-established themselves in the eastern counties on the mainland and are spreading westwards. The highest densities are found in farming areas.

ASSOCIATED HABITATS

H11-14 Open Freshwater, H17 Barren, H18 Oldfield, H20 Talus Slope, H22-34 Forested Habitats

REFERENCES

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Benson and Dodds (1977)
Cameron (1958)
Dodds (1969)
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Eastern Ecological Research (1976)
Environment Canada, Lands Directorate (1980)
Gilhen and Scott (1981)
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N.S. Dept. of Lands & Forests (1980)
Prescott (1980)
Telfer (1967)

T58 Amphibians and Reptiles

The amphibians and reptiles are normally treated together as herpetofauna although they represent two different vertebrate classes with distinct characteristics and habitat requirements. There are 25 species recorded from Nova Scotia including three marine turtles. The fauna is relatively poor when compared to adjacent mainland areas of the continent. Post glacial colonization was mainly by the Chignecto isthumus (unit 523), but also from the coastal plain refugia. Some species are not uniformly distributed and the distribution patterns that exist reflect the past colonization routes, climate and habitat factors. As the climate of the area cooled at the end of the hypsithermal period several Nova Scotia species became isolated from the main continental populations. Due to this isolation these species tend to show a higher degree of morphological variation than is seen in continental populations. The survival of the amphibian and reptile species in Nova Scotia depends heavily upon climate and available habitat for breeding and hibernation.

AMPHIBIANS

There are 13 species which include five salamanders and eight frogs. With the exception of the Eastern Redback Salamander, these species are dependent upon water for reproduction. There is a distinct spring or early summer mating and egg-laying period, and larval development takes place throughout the summer. Metamorphosis usually takes place from mid to late summer. For tadpoles of the frogs this involves a change from aquatic herbivore to largely terrestrial carnivore. Amphibians normally spend the winter either in the soil or in bottom sediments of ponds.

Dependence on water for functions other than breeding, varies between species. Among the salamanders, there is a tendency towards independence from water. Adult Blue Spotted and Yellow Spotted Salamanders remain in the ponds for only a few days in order to breed, the Eastern Redback Salamander does not even breed in water, whereas the newt is mostly aquatic during its adult life. The adult American Toad, Northern Spring Peeper and Wood Frog are largely independent of water except for breeding, whereas the Bullfrog has a prolonged larval development and spends almost all of its adult life in the water.

The availability of breeding ponds close to woodland habitats is the most important ecological consideration for amphibians. The construction of isolated ponds and ditches has been of great benefit to amphibians as the larval development can proceed at a faster rate in the warm, shallow water and there is only limited predation by fish.

REPTILES

The reptiles fall into three distinct groups; the snakes with five species, the freshwater turtles with four species and the marine turtles with three species recorded in Nova Scotia waters. Of the snakes three, the Northern Redbelly Snake, Maritime Garter Snake and Eastern Smooth Green Snake are found throughout the province, particularly in marginal ecotone situations which provide shelter, food and open areas for sunning. The Northern Ribbon Snake is restricted to Queens and Lunenburg Counties, in habitats along the edge of water. The Northern Ringneck Snake occurs only in the granite and quartzite areas of the Atlantic uplands and in parts of Cape Breton.

Snakes exhibit two forms of reproduction, egg-laying and live bearing of young. The two egg-laying species, the Northern Ringneck Snake and Eastern Smooth Green Snake require adequate nesting sites, for example under rocks, where eggs can be laid and remain protected during development. Snakes require places in which to hibernate during the winter. None of these species is poisonous.

The freshwater turtles spend a large part of their time in association with water, but must come ashore to find sand or gravel banks and loose soil situations in which to lay their eggs. The Wood Turtle often spends the daytime during summers away from water, but like the other species must hibernate under water. Turtles are most common in mainland Nova Scotia, but may have limited distributions. Painted Turtles are common in the central and southwestern parts of the province, but only a few isolated populations have been reported from the northern part of the mainland. Only the Wood Turtle occurs naturally in Cape Breton Island. Common Snapping Turtles are common in mainland Nova Scotia. Records from Cape Breton are believed to be introductions.

Three marine turtle species have been recorded from Nova Scotia waters; Atlantic Ridley, Atlantic Loggerhead and Atlantic Leatherback. It is the last mentioned that is usually brought to the attention of the public because of its large size. These animals are summer visitors only. They breed in the tropics.

SPECIAL FEATURES

Because of restricted distribution and particular habitat requirements some species of reptiles are considered vulnerable to disturbance and require protection. The

Blandings Turtle is protected within the bounds of Kejimkujik National Park. The Wood Turtle, which occurs in some watersheds in northern mainland Nova Scotia and Cape Breton, is vulnerable during early development, and also during adult life when specimens are taken as pets and later released away from the main breeding populations. Marine turtles are protected in their breeding sites in the tropics, but not as adults when occuring in Nova Scotian waters. Specimens caught in fishing nets are not normally released in sufficient time to survive.

Several species show interesting morphological variation within populations. Of particular interest are the dark or Melanistic variety of the Maritime Garter Snake, coloured pattern variation on the Northern Ringneck Snake and triploid individuals of the Blue-spotted Salamander.

ASSOCIATED TOPICS

H17 Colonization by Animals

ASSOCIATED HABITATS

H10-17 Freshwater Habitats

REFERENCES

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Gilhen (1984)
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Martin (1954)

T59 Land and Freshwater Invertebrates

It is a common situation that the most diverse and numerous animals, the invertebrates, are generally the most poorly known. This holds true for Nova Scotia, and is due to the small size and obscure habitats of many species, particularly those that inhabit the soil or bottom sediments of lakes and ponds. Although representatives of most land and freshwater invertebrate groups are known to occur in the province, complete or even adequate lists of species are not available. Information on the biology of those species that do occur is most often drawn from studies carried out elsewhere. Invertebrate animals are found everywhere and this reflects their important roles in ecosystems. In a general sense their roles can be demonstrated without specific identification. However, in such cases as parasite infections, defoliation of commercial forest trees or where detailed ecological studies are required, specific identifications are essential as a basis for understanding and communicating life histories. Some species have complex life histories with distinct larval forms, which sometimes occupy different habitats than the adults. It is often necessary to rear the animals through their life cycles in order to make the correct associations between adult and larva, and in some cases to demonstrate sexual dimorphism.

Diversity

A general review of the collections of the Nova Scotia Museum and some published lists indicates that there are more than 15,000 species of land and freshwater invertebrates in Nova Scotia. Table 13 shows a breakdown of this total into various groups.

Two things are obvious from the list. Firstly, the dominant taxa are all insects, with the arachnids (spiders and allies) being the next most important. Secondly, the state of knowledge of the lower taxa, protozoa through Nematoda, is extremely poor. These low numbers generally indicate inadequate study and extensive species lists can be expected with more work. For example, only 17 species of rotifers are recorded although some 362 species are known for Canada as a whole. However, it must be remembered that the Nova Scotia fauna

Table 13

Numbers of Land and Freshwater Invertebrates

Approximate numbers of invertebrate species recorded or estimated for land and freshwater habitats in Nova Scotia. Based upon limited literature search.

Group	Approximate number of Species
Protozoa	?
Porifera (sponges)	2
Coelenterata	2
Platyhelminthes - Turbellaria (flat worms)	2
- Cestoda (tape worms)	2
- Trematoda (flukes)	?
Rotifera	17
Nematomorpha (hair and ribbon worms)	1
Nematoda (round worms)	?
Mollusca - Gastropoda (snails, slugs)	80
- Bivalvia (clams, mussels)	18
Oligochaeta (earthworms, etc.)	15
Hirudinea (Leeches)	19
Diplopoda (Millipedes)	6
Chilopoda (Centipedes)	1
Insecta - Lepidoptera (moths, butterflies)	2,000
- Diptera (flies)	3,000
- Coleoptera (beetles)	3,000
- Hymenoptera (bees, wasps, ants)	2,500
- Hemiptera (bugs)	1,500
- other orders	1,000
Arachnids (spiders, ticks, mites)	1,500
Crustacea (water fleas, sowbugs, etc.)	more than 60

is considered to be impoverished when compared to the rest of eastern North America. In the case of insects the total of approximately 13,000 species in Nova Scotia is low compared with 25,000 species recorded in Ontario. A similar situation exists with the freshwater mussels (Unionidae) where Nova Scotia has only 9 of the 46 species recorded from eastern Canada as a whole.

Distribution of Native Species

Because of the lack of records in most groups there is no detailed information on the distribution of invertebrates in Nova Scotia. Collections of molluscs and freshwater crustacea and insects do indicate some patterns that are seen to be closely related to distributions of various elements of the flora. Food plants, climate and other habitat factors are important for all species including the flying insects which, although capable of wide distribution, are limited by the requirements of their larval stages.

Many species are common and ubiquitous, such as the freshwater amphipod, Hyalella azteca and the land snail, Zonitoides arboreus. Other species however, show limited distributions that reflect their mode of colonization. The freshwater Isopod crustacean, Asellus sp. is restricted to southwestern Nova Scotia and probably originates from the coastal plain refugia of the glacial period. The land snail, Mesodon sayanus found in Cumberland County is an example of colonization across the Chignecto Isthmus land bridge.

The original post glacial (late, Pleistocene) fauna that occupied Nova Scotia was gradually displaced by the fauna of adjacent areas. Although there are no true Arctic/Alpine habitats left there is evidence of species (eg. of the Lepidoptera) with arctic affinities remaining in bog and barren habitats along the coast and in the Cape Breton Highlands. This is also supported by recent collections of freshwater crustacea.

The southern pine/hemlock forest and oak woodlands each have their own distinct Lepidoptera species. Many of these species do not extend into the spruce and fir forests which have a characteristic boreal fauna of their own.

The species of insects that inhabit the upper levels of saltmarshes and other seashores are fairly distinct and are often found on both sides of the Atlantic.

Introduced Fauna

In Nova Scotia it is important to differentiate between native and introduced species. The dumping of ships' ballast, importation of plants for agriculture and horticulture and trans-shipment of goods since at least the 17th century, resulted in the introduction of many species. These species arrived as land was cleared for agriculture and development, activities which caused the destruction of native habitats and their associated soils, and the decline of native species. For example, there are nine species of slug recorded from Nova Scotia of which six are definitely introduced. Some of the slugs are very aggressive and colonize native habitats directly or through the course of succession, while others have remained close to the point of introduction. The native slug species of the family Philomicidae are now restricted to native woodland habitats. The 15 species of Lumbricid earthworms, familiar to many people as "night crawlers", are all introductions. They live mainly in cultivated land but have also invaded second growth forest and other habitats.

Gardeners will be familiar with the large black ground beetles and long, slender click beetles which were imported in ballast along with cellar bugs, centipedes, millipedes, earthworms and numerous other groups of invertebrates. In urban areas everyone is aware of rats and mice, cockroaches, bedbugs, carpet beetles, flour beetles, clothes moths, flour moths, earwigs, fleas, lice, houseflies and booklice, all of which have been unwittingly introduced.

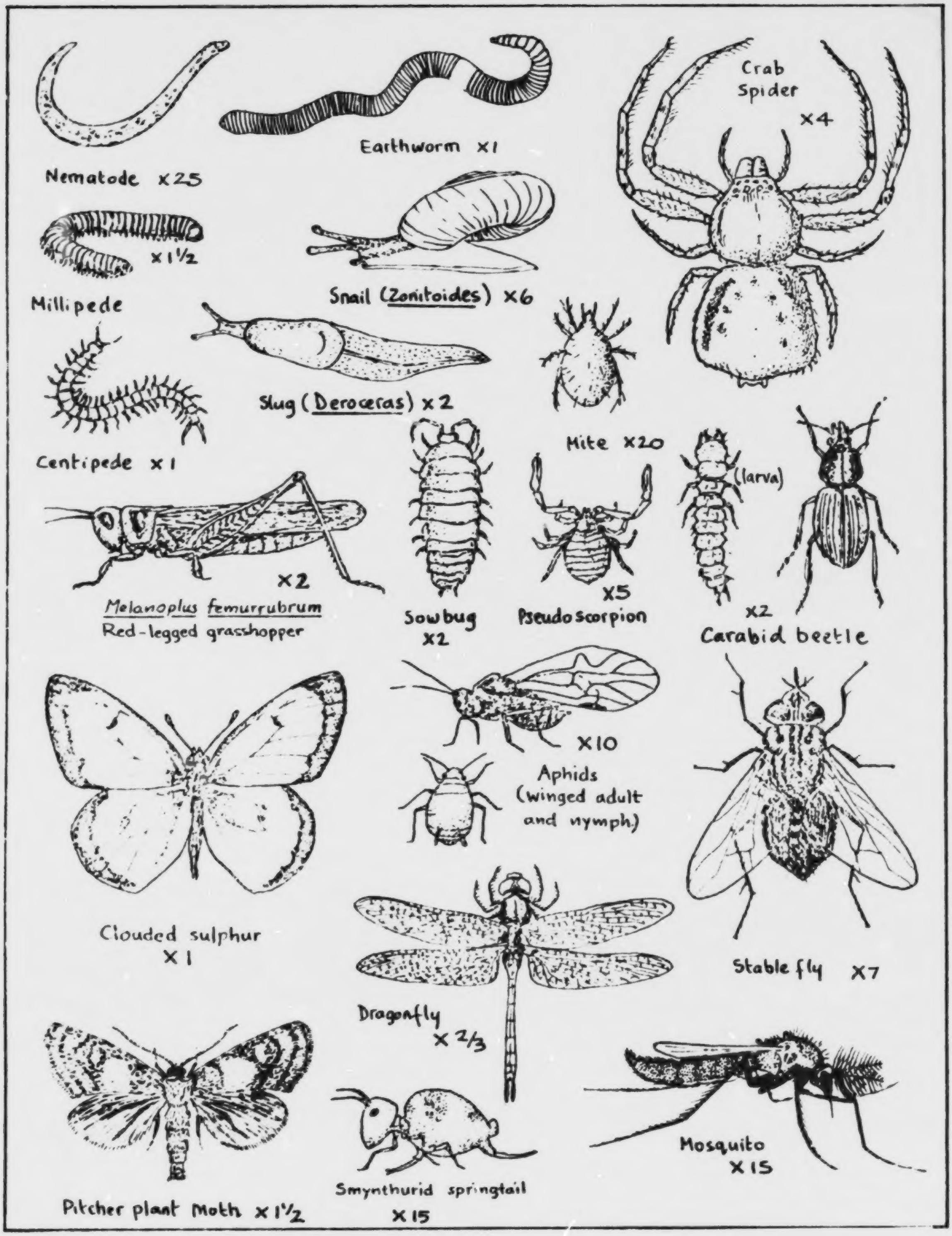
Nematode x25
Earthworm x1
Crab Spider x4
Millipede x1½
Snail (Zonitoides) x6
Slug (Deroceras) x2
Mite x20
Centipede x1
Melanoplus femurrubrum
Red-legged grasshopper
x2
Sowbug x2
Pseudoscorpion x5
(larva)
Carabid beetle x2
Aphids (winged adult and nymph) x10
Clouded sulphur x1
Stable fly x7
Dragonfly x 2/3
Pitcher plant Moth x1½
Smynthurid springtail x15
Mosquito x15

Fig. 64. Examples of land invertebrates found in Nova Scotia (Note: enlargements or reductions are approximate).

From time to time, forest pests have been accidentally introduced and, since they arrived as adults without the accompanying diseases, parasites and predators which affect their larvae, multiplied rapidly with disastrous results. The Gypsy Moth, Winter Moth, Brown-tail Moth, Satin Moth, European Pine Shoot Moth and Larch Casebearer have been the subject of control programs, along with aphids, scale insects and sawflies on pine, spruce, Larch and Mountain Ash.

Soil Invertebrates

Many important aspects of terrestrial ecology and zoogeography relate to the fauna of the soil. This fauna includes burrowing mammals and amphibians, but the majority of species are minute invertebrates. These animals in many cases have close affinities with aquatic faunas, eg. worms and crustaceans, and as a result are very dependent upon moisture. Lack of water in the soil due to drought or disturbance can be very detrimental to these organisms. The main groups included in the soil fauna are protozoa, flatworms, nematodes, rotifers, lumbricid and enchytraeid worms (oligochaetes), snails and slugs (molluscs), tardigrades, crustaceans, arachnids, insects and other arthropod groups. Many of these animals are very small and constitute the soil meiofauna. Because of their small size and delicate forms they must be collected and preserved using special techniques. The great diversity of species means that identification is a major problem, often requiring specialized knowledge. The Nematoda, for example include some 2,000 species on a world-wide basis and a sample of one cubic decimetre (about 60 cubic inches) of forest soil could contain as many as 30,000 individuals.

These animals function in the complex food chains that reduce leaf litter to humus and their activities are important in the maintenance of good conditions in the soil.

Further studies of soil fauna could reveal important details of changes in soil character during forest succession. The animals of old forest soils in mature stands as well as in caves could also provide some insights into the origin of the Nova Scotia fauna.

Insects and Vegetation

The niche of herbivore in land and freshwater ecosystems is largely occupied by insects, particularly the grasshoppers, leaf hoppers, leaf bugs, aphids, leafbeetles, sawflies, and larval stages of butterflies and moths. Many species are specific to certain food plants and may become of concern when these are agricultural crops or commercial forest trees. Insects play an important role in the pollination of flowers. There are many ways in which insects interact with plants. A few examples are given below.

The Spruce Budworm, caterpillars of the moth, Choristoneura fumiferana, feed upon the young shoots of fir and spruce trees causing severe growth retardation and even death of the tree. The occurrence of high level populations is cyclic and naturally would be controlled by predators, parasites and diseases. Attempts have been made to control Spruce Budworm by chemical spraying but this has disrupted the natural 40 year cycle and maintained an artificially high population poised for re-infestation.

Other moth larvae such as the White-marked Tussuck and Forest Tent Caterpillar periodically defoliate hardwoods in certain areas of the province. Though many trees are killed by successive infestations, this mortality is not commercially significant and the effects on the forest are short-lived.

Dutch Elm disease is a fungus parasite that is transmitted by the native Elm Bark Beetle, Hylurgopinus rufipes. The larvae develop under the bark of dead branches and the adult feeds on the bark of young shoots. The beetle carries the spores from one tree to another. The disease has been spreading for many years and is currently affecting trees in Nova Scotia.

Galls, oak apples, mossy rose galls, willow pine galls and a great variety of often colourful growths on leaves and stems of plants, are caused by insects. The galls form in response to a chemical released by the developing larvae of gall flies, (Ecidomyidae) or gall wasps (Cynipidae). The larvae feed throughout the summer and over-winter in the galls, emerging as adults the following spring.

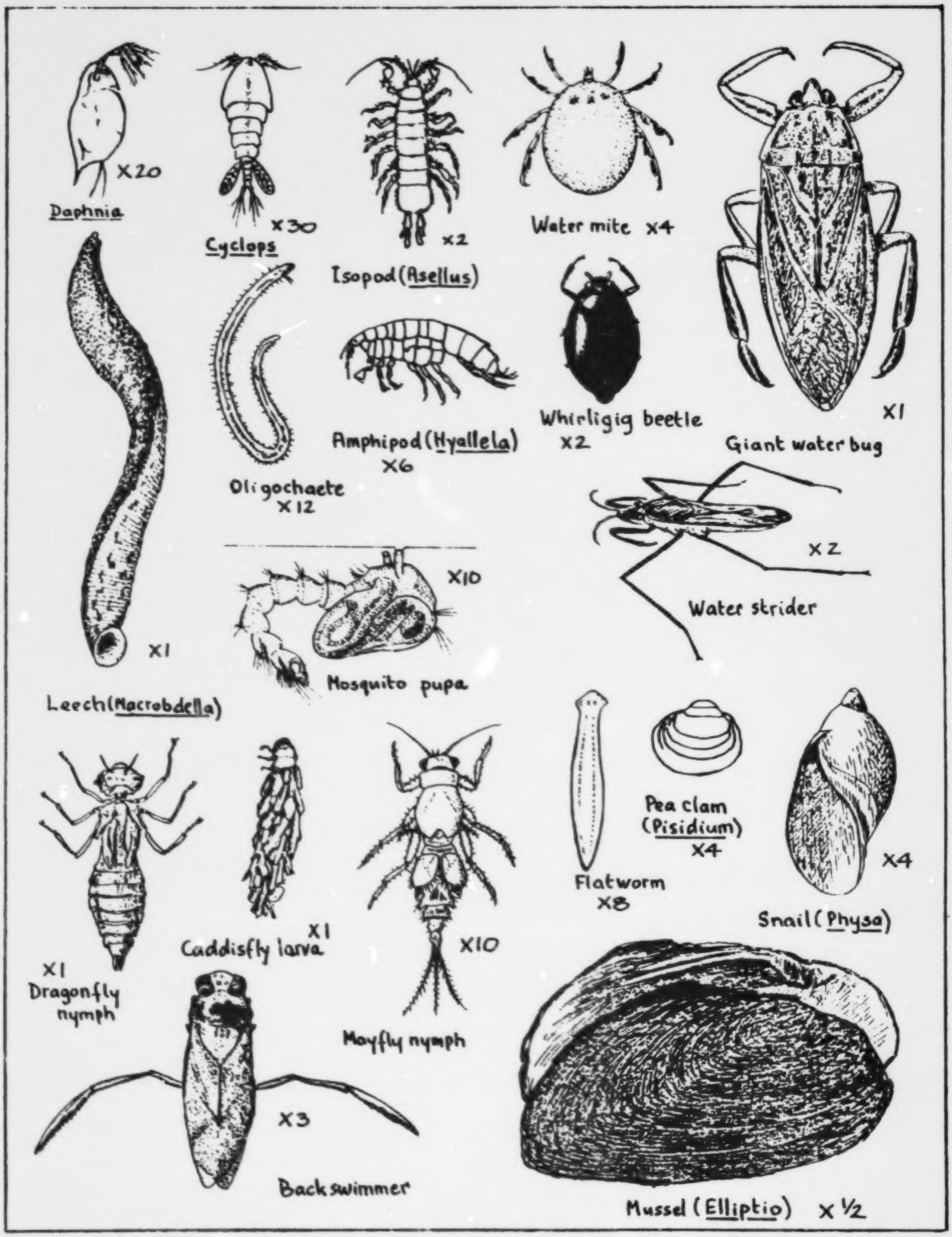
X20
Daphnia
X30
Cyclops
X2
Isopod (Asellus)
Water mite X4
X1
Giant water bug
Oligochaete
X12
Amphipod (Hyallela)
X6
Whirligig beetle
X2
X2
Water strider
X10
Mosquito pupa
X1
Leech (Macrobdella)
Flatworm
X8
Pea clam
(Pisidium)
X4
X4
Snail (Physa)
X1
Dragonfly
nymph
X1
Caddisfly larva
X10
Mayfly nymph
X3
Backswimmer
Mussel (Elliptio) X ½

Fig. 65. Examples of freshwater invertebrates found in Nova Scotia (Note: enlargements or reductions are approximate).

The Cinnabar moth, Tyria jacobaeae, was unsuccessfully introduced at Northwest Margaree in the early 1960s and later, in 1963, was established at Durham, Pictou County. The gregarious, black and yellow banded caterpillars completely destroy their food plants, Ragwort, and are considered to be a positive biological control agent. The handsome black and red moths are now abundant in Cape Breton and northern mainland Nova Scotia, wherever Ragwort, the bane of hay fever sufferers, is most common.

Freshwater Invertebrates

Nova Scotia has a great many lakes, ponds, rivers and streams which provide varied habitats for freshwater animals. Water quality, related to geology and soil condition, has an important influence on the distribution and abundance of species. Many species, particularly molluscs with calcareous shells, are not found in waters with low pH and populations of tolerant species such as insects tend to be low due to the dystrophic condition. Waters with higher pH tend to be oligotrophic and have more diverse and larger populations of invertebrates.

The conspicuous fauna is largely composed of the larvae of insects with crustacea, arachnids, gastropod and bivalve molluscs, leeches, oligochaetes, flatworms, coelenterates and sponges also present. There is an important microscopic meiofauna in the bottom mud which includes, Crustacea, Rotifera, Nematoda and Protozoa. In lakes the herbivores are most often crustaceans; insects are the major herbivores on wetlands and streams.

The vegetation zones at the margins of ponds, lakes and slow moving streams provide the best habitat for freshwater invertebrates. Beside providing the food for the herbivores, the plants also provide a link between the bottom and the surface, needed by air breathing molluscs and emergent insects such as dragonflies. The plants are often heavily colonized by animals. This fauna is generally reduced in conditions of exposure to waves, as in large lakes or in fast moving rivers and streams. In the latter case the animals often show distinct adaptations for feeding and maintaining position.

For example stoneflies, typical of stony bottoms of rivers have flattened, streamlined bodies. In small vernal ponds which tend to dry up in the late summer the species of snails (Fossaria sp.), Crustacea and insects have to complete their reproduction and development before the habitat becomes too dry. Adults, eggs or larvae, depending upon the species, will estivate in the bottom sediment.

Most permanent bodies of water will have a community of planktonic animals composed of protozoa, rotifers and crustaceans, particularly copepods (eg. Cyclops sp.) and cladocerans (eg. Daphnia sp.). This community is best distinguished in larger lakes and, as with marine zooplankton, depends upon the primary production of phytoplankton.

The insects that inhabitat freshwater, may do so throughout their lives (eg. water bugs and water beetles) or, more commonly, only during larval development. This larval development is usually the longest part of the insect's life. The flying stage, often of very short duration, is for dispersal and mating. The larvae of dragonflies, damselflies, caddisflies, mayflies, stoneflies and chironomids that belong to this group are among the most conspicuous of freshwater invertebrates and are of great importance as food for many fish species.

Special Features

1. Endemic species and subspecies. There are no known endemic invertebrate species on mainland Nova Scotia. There are endemic subspecies, the best known being the Short-tailed Swallowtail Butterfly, Papilio brevicauda bretonensis, which occurs only in northern Cape Breton Island, though its foodplant, Scotch Lovage, is found on coasts around the province.

2. Sable Island. There is an increasing amount of evidence to suggest that Sable Island was a glacial refugium for many species of invertebrates which failed to return to, or survive on, the mainland. So far, a sponge Heteromeyenia macouni, two species of moths, Agrotis arenarius and an undescribed Papaipema sp., and a beetle, Pyrrhalta sablensis have

been discovered. Several sub-species and unusual forms of moths have been collected though only one, Orgyia leucostigma sablensis, has been named.

3. American Dog Tick. This unwanted immigrant from the Eastern United States arrived in southwestern Nova Scotia during the 1930's and 40's. Although it is not a serious pest, and at the moment transmits no diseases to man, in Nova Scotia it is certainly a deterrent to outdoor summer recreation in that part of the province where it is abundant from late May to early July. At present the main population is confined west of Highway 10 between Bridgewater and Middleton with isolated outbreaks occurring as far east as Glace Bay, wherever gravid females have dropped off their hosts, principally dogs, into suitable terrain. All stages in the life history are ectoparasites, feeding on the blood of a series of hosts to which they become attached for short periods of time.

Rare Species

Because of limited knowledge of distributions it is difficult to distinguish and justify a status of rare to the invertebrate species. In a provincial context the preservation of representative habitats should adequately protect the soil and freshwater invertebrates, including those species not yet discovered and identified. Particular attention should be paid to the fauna of soil in old mature forests which which is the main habitat for the undisturbed native fauna.

Two species of freshwater mollusc native to eastern North America are considered rare in a Canadian context. These are the planorbiid snail Menetus dilatatus from Atlantic coast waters and the Yellow-lamp Mussel, Lampsilis cariosa, which occurs in the Sydney River and in New Brunswick.

Apart from the previously mentioned endemic species and sub-species of insects in sections 1 and 2, most of our rare native species are found in Cape Breton. For example, the Bog Horsefly, Haematopota rara, recently discovered on the Big Barren near Middle River, Cape Breton Island (district 210), was previously known from only sixteen specimens collected in New Jersey, Pennsylvania and Ohio. *Syngrapha surena*, a moth, is also common on the Big Barren, though rarely encountered elsewhere. This moth, rare in collections, is also found in Northern Ontario, Quebec, Labrador and Newfoundland. *Oeneis jutta*, an arctic butterfly flies among black spruce trees at the margins of bogs near Mount Uniacke. Two other butterflies, rare in collections, are found in southern Nova Scotia: *Incisalia lanoraiensis* at Gold River and Bridgewater in Lunenburg County and *Erora laeta* in Armdale, Halifax County, and at Digby.

ASSOCIATED TOPICS

T15-17 Colonization.

ASSOCIATED HABITATS

H7 Saltmarsh, H8-9 Associated Coastal Habitats, H10-16 Freshwater Habitats, H17-34 Terrestrial Habitats

REFERENCES

Belyea *et al* (1975)
Chengalath (1977)
Claridge and Burleson (1978)
Clarke (1981)
Ferguson (1955)
Harris *et al* (1975)
Isnor (1981)
LeBlanc and McClung (1979)
Reynolds (1976)

T60 Freshwater Fishes

A total of thirty-seven species of fish have been recorded in the lakes and streams of Nova Scotia. Of these only fifteen, including two introduced species, can be classified as purely freshwater species. The remaining fish either spend a large part of their lives in the sea or can at least move into salt water with ease. In addition certain marine species which are commonly found in estuaries also sometimes move up into the lower reaches of rivers. Thus the fish fauna of Nova Scotia's lakes and streams is characterized by two prominent features which both relate to the insular nature of the province:

1) The fish fauna is impoverished, compared to the numbers of species found further west (a feature shared by the flora and other fauna of the province)
2) The fauna is heavily influenced by the salt water environment which surrounds Nova Scotia.

Distribution

The thirteen purely freshwater native species have all entered Nova Scotia by way of the narrow isthmus of Chignecto (unit 523) during the thirteen thousand years since the retreat of the last ice sheet. Before human intervention movement from one watershed to another would depend on river capture (see T12 Tertiary Drainage Patterns) or on the freshening of the coastal waters by the melting ice sheet, thus enabling freshwater species to move around the coast from one river to another.

The pattern of distribution shows a definite decline in species diversity, moving away from the Chignecto lowlands. This pattern may be explained in two ways. One interpretation sees it as the result of incomplete colonization. The increase in species in the Cumberland County area suggests that certain fish, such as the Blacknose Dace, have not yet been able to penetrate any further into the province. The absence of any purely freshwater species on Digby Neck and in northern Cape Breton is thus a reflection of their distance from the point of entry. The second intrepretation sees the pattern as an indication that many species were once much more widely distributed and have since been eliminated from certain regions by habitat and competition factors. The high species diversity in Cumberland County therefore becomes a reflection of the higher productivity of freshwater environments in that area compared to the waters of the southern upland. This interpretation also helps to explain the small, isolated populations of the Atlantic Whitefish in pockets of suitable habitat in southwest Nova Scotia.

Species which exhibit various degrees of tolerance to saltwater were able to move more readily from one river system to another via the sea, and are therefore more widely distributed.

Human intervention has also been an important factor. Five species - the Rainbow Trout, Brown Trout, Chain Pickerel, Lake Whitefish and Smallmouth Bass - have been introduced through public stocking programs and by private initiative. Dams constructed for logging and power generation purposes have changed distributions by impeding the passage of fish to spawning grounds.

It is possible that species information is still not complete, perhaps because non-game species have not received the same attention as their more edible neighbours. It is possible that a number of fish, such as the Arctic Char, which are common in New Brunswick, may also occur in Nova Scotia.

Water Quality Factors

The influence of factors such as climate and water quality on distribution at the regional scale is not yet fully known. The water temperature regime will vary considerably from one lake to another, depending on basin size and shape. But in general the waters of southwest Nova Scotia are somewhat warmer than in the rest of the province and some warmer water species, appear to be at the northern limit of their range in this area.

The influence of water chemistry on different species still requires further study. In general the harder waters of the sedimentary rock areas support a larger number of species. Certain species have not been recorded in the granitic areas and it is possible that they cannot tolerate the low mineral content of the very soft waters.

Habitat Factors

One consequence of the limited number of species in Nova Scotia is that the reduced competition permits them to occupy a wider range of ecological niches. For example, the Banded Killifish throughout most of its range in North America is restricted to weedy lake shallows and slow-moving streams. In Nova Scotia however it is also found in swift-flowing streams and deep open water. Similarly many of the salmonids occupy a wider variety of niches than is customary elsewhere. In some areas the trout population is being displaced from marginal habitats by increasing competition from the Chain Pickerel and Smallmouth Bass.

Moving Water Environments

River systems generally exhibit a gradation of lotic or moving water environments ranging from shallow, fast, turbulent waters in the headwaters down to the slower, deeper waters of the lower reaches. In regions which have a diverse fish fauna a comparable zonation of species often evolves, but in Nova Scotia this is less obvious because many species occupy a large range of niches. In general, upstream fishes have a high metabolic rate and therefore a high oxygen demand, and have the ability to hold their position in swift currents. The salmonids are typical species of this habitat. In the slower moving waters minnows and perch are more typical. As the water slows down even further the larger bottom feeding species such as bass become more common. Because of the comparatively gentle slope of the Atlantic Interior (region 400) and the predominance of the deranged drainage pattern in many areas much of Nova Scotia is drained by slower moving waters.

Still Water Environments

Lentic or still water environments are characterized by size, circulation patterns and trophic status. A large deep lake will usually become thermally stratified in the summer, permitting the year round existence of cold water fish in the deeper layers. Oligotrophic lakes, which predominate in Nova Scotia, have abundant oxygen at all depths but low nutrient levels. They can only support a low biomass and fish growth is slow. Trout are the characteristic species. Eutrophic lakes are more productive but have lower oxygen content.

The trout species disappear and are replaced by pike, perch, killifish and bullheads.

Migratory Species

A number of species are anadromous: they mature in salt water but return to fresh water to spawn. Included in this group are gaspereau, salmon, Striped Bass, Atlantic Whitefish and the lamprey. The eel is the only catadromous species found in North America. Eels leave freshwater in fall and migrate to the Sargasso Sea to spawn.

Special Features

The Lake Whitefish is elsewhere a valuable freshwater species. In Nova Scotia only two populations were once thought to exist in Kejimkujik and Mountain Lakes, both in Kejimkujik National Park. However, Lake Whitefish have since been widely introduced and are now known to exist in Cobrielle and Peskowesk Lakes in Kejimkujik Park, and also in several lakes near Musquodoboit Harbour and in at least one in the St. Marys drainage basin. They are, however, apparently more common in western Nova Scotia. The Lake Whitefish is a cool water species which feeds on benthic invertebrates, and requires lakes which are stratified in summer. The Nova Scotia populations exhibit very slow growth rates and are considered to be vulnerable.

The first record of an Acadian Whitefish, once known as the Atlantic Whitefish, was established in 1925, and the only populations in the world are found in the Tusket River system, and in Millipsigate Lake in Lunenburg County.

Of special interest is the recent establishment of Coho Salmon in the Cornwallis River system. These are apparently colonists from stocking programs in the U.S.

ASSOCIATED TOPICS

T29-30 Surface Waters

ASSOCIATED HABITATS

H10-14 Open Freshwater

REFERENCES

Gilhen (1974)
Livingstone (1951)

T61 Marine Fishes

The line between freshwater and marine fishes is not always easy to draw as certain species move freely between both systems. The marine fishes likely to be found in Nova Scotia's coastal waters may be divided into five groups:
1. Small fishes of estuaries and tidal inlets;
2. Groundfish
3. Pelagic species
4. Mesopelagic species
5. Exotic warm water and eastern arctic species.

Fishes in the first group depend on the types of intertidal and subtidal habitats available. The concentrations and movements of the other groups relate to temperature, salinity, bottom characteristics and food resources - factors which are closely dependant on the movements of the major water masses in the northwest Atlantic and on the bathymetry of the Continental Shelf. Generally speaking the shallow water environments offer more opportunities for specialization and therefore have high species diversity. Further offshore the species diversity is lower but the biomass is high - the feature on which the great fisheries of the Atlantic coast are based.

Estuarine and Tidal Inlet Fish

This group includes fishes such as mummichog, pipefish and several stickleback species which spend most of their lives in brackish estuarine waters. But many other fish may at some time be found in these habitats, either moving through to spawning grounds or coming into feed. Fifteen to twenty fish species are commonly found in Nova Scotia's estuarine systems - fewer than more southerly systems on the Atlantic coast. They include flounders, eel, Striped Bass, young trout, salmon, smelt, gaspereau and tomcod.

Intertidal habitats often offer abundant food resources, but can also be stressful environments. Fish may have to withstand strong wave motion, and fluctuating temperatures and salinities. Salt marsh and eelgrass beds are important components of the intertidal environment. Few animals feed directly on the living plants. Instead the food chain begins with plant detritus. It is apparent that detritus washing out of the estuarine system supports a "spike" of high plankton productivity which is then washed back in by the incoming tide.

Groundfish

Groundfish are bottom feeding species, seeking out worms, molluscs and crustaceans. Some groundfish also go through pelagic stages during which they feed nearer the surface on plankton and small fish. Juveniles may also move inshore to feed in estuarine habitats. The groundfish group include cod, flatfishes (flounder, plaice, halibut and turbot) redfish, haddock, pollock and hake. Many species are gregarious and move about in schools. Many of the groundfish show a narrow tolerance for temperature change, and their seasonal movements are largely governed by the position of the water layers of suitable temperature and salinity in relation to bottom areas of suitable substrate.

An example is provided by cod migrations on the Scotian Shelf. Cod are most often found in waters between 40 and 43°F (4 and 6°C). In April they spawn over the Sable Island and Banquereau banks in the deeper, warmer waters which lie below westerly drifting water derived from the Labrador Current. As the summer progresses this bottom water gradually warms up above the range of the cod. The cold layers nearer the surface gradually reach suitable temperatures and the cod is able to move closer inshore. Winds are also a factor. During calm weather the warm layer is relatively thin, but strong onshore winds will mix warm surface and deeper colder waters, creating a much wider inshore zone suitable for cod browsing. Cod are concentrated in four principal stocks - the Nova Scotia coastal stock, the Browns - LaHave Banks stock, the Georges Bank stock and the Banquereau-Sable Island stock. In the Gulf of St. Lawrence cod spawn on the Magdalen Shelf and move eastwards to overwinter on the southern edge of the Laurentian Channel off Cape Breton Island.

Pelagic Species

Pelagic species are those which range the open sea, feeding mostly in surface and middle depth waters. They often travel in large schools.

Pelagic fish include herring, mackerel, swordfish, tuna, smelt and capelin. Salmon, gaspereau and eels, all of which spend time in freshwater, can also be included in this group. Pelagic species feed chiefly on plankton, small crustaceans and other small fish. Most pelagic species migrate in response to temperature changes and food resources. The major Nova Scotia herring stock migrates from the Bay of Fundy to overwinter in the Chedabucto Bay area. Mackerel move southwards and in towards the coast in summer. Quite often they will move into bays and estuaries in search of food, and are sometimes followed by the Bluefin Tuna. In fall the mackerel move northwards towards the zone of warmer water which flanks the outer edge of the Continental Shelf.

It has also now been recognized that several species of pelagic fish migrate in the summer into the highly "stressed" macrotidal portions of the Bay of Fundy, presumably in response to the extremely high abundance of invertebrates. This distinct migration was originally established for the American Shad. Tags inserted in fish caught in Cumberland Basin and Minas Basin have been returned from all major spawning rivers of the U.S., from Florida northwards. It now appears that similar migration behaviour occurs in gaspereau (alewife and Blueback Herring), Striped Bass, Porbeagle Sharks and others.

Mesopelagic Species

Mesopelagic species are those which live on the Continental slope. They include lanternfishes and Myctophids. One feature of many of these deepwater species is their vertical migration towards the surface at night. The fish thus have to be able to withstand drastic pressure changes. Although mesopelagic fish are themselves unlikely to be seen in inshore waters they are of interest because they constitute an important food resource for seabirds, such as petrels, which are more visible.

Exotic Warm Water and Eastern Arctic Species

The coastal fish fauna of Nova Scotia is much enriched by a variety of exotic visitors. Many are associated with warm water brought in by slope water exchange. They often move in as juveniles, carried in the warm water eddies which break off from the main Gulf Stream. They spend the summer in tidal inlets, taking advantage of the warmest surface temperatures between August and November, but then cannot survive the winter. Studies in St. Margarets Bay and Prospect Bay produced a collection of thirty-one species from southern warmer waters. These fish include flying fish, seahorses, priacanthids and mullet. Several species of shark can also be associated with this group, including the dusky, silky, whitetip, hammerhead, and mako - all of which occur in the warm waters of the Gulf Stream. In addition, several species of eastern arctic orgin such as the Greenland Cod, Mailed Sculpin and Arctic Eelpout, have been recorded from cold water areas on the banks and eastern shore.

ASSOCIATED TOPICS

H23 Oceanic Environments

ASSOCIATED HABITATS

H1-2 Offshore Habitats, H7 Salt Marsh

REFERENCES

Brookes (1972)
Leim and Scott (1966)
Scott (1976)

T62 Marine Mammals

SEALS

Two species of seal are commonly found in Nova Scotia waters: the Harbour Seal (*Phoca vitulina*) and the Grey Seal (*Halichoerus grypus*). The populations of the two species are inversely related to a degree because their preferred food supplies somewhat overlap. Harp Seals are also occasionally seen in late March-April, particularly in the Cape North - St. Paul's Island area, as they drift eastwards from their breeding grounds on the Magdalen Islands. similarly the Hooded Seal may sometimes be seen off the west coast of Cape Breton.

HARBOUR SEAL

The Harbour Seal is widely scattered, congregating in groups of up to several hundred in the breeding season, and at favourite feeding grounds in the late summer and fall (Figure 66). The young seals wander, but the adults are sedentary, forming discrete and fairly isolated local populations. Whelping begins in early May, with mating occurring soon after. Moulting takes place in July. The harbour seal is a year-round resident but sightings in winter are fewer because the seals do not like to haul out when temperatures are very low.

Distribution	The Harbour Seal is predominantly associated with inlets, islets and reefs. The numbers of seals have been found to be closely correlated with the number of small islands along a given piece of coast. The largest numbers in Nova Scotia are found along the Atlantic Coast (region 800) between Louisbourg and Shelburne and on Sable Island (region 900). They avoid ice, moving further offshore in the winter if inlets freeze. The Harbour Seal likes freshwater and may move into estuaries, rivers or lakes. Breeding takes place on reefs and rocky islets, and on sandbars or mudflats in estuaries.
Feeding Pattern	The basic diet consists of non-migratory bottom fish, particularly flounder and hake, and occasional invertebrates. In the summer, however, when large schools of fish and squid migrate inshore, herring, squid, alewife, smelt and mackerel form the main food supply.

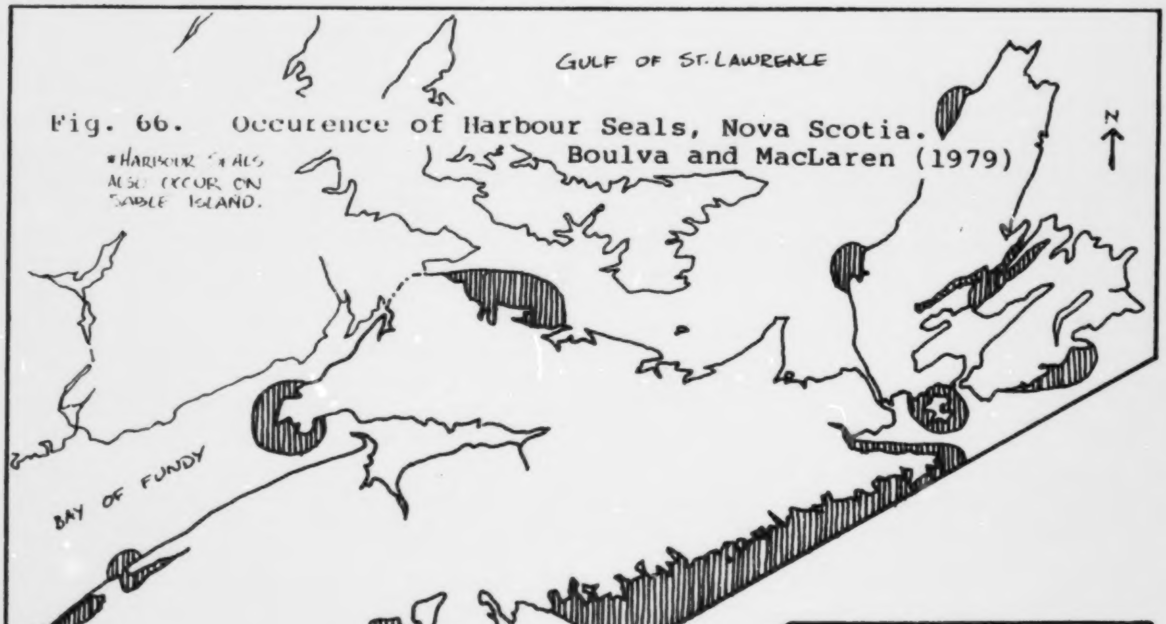
GULF OF ST. LAWRENCE
N
BAY OF FUNDY

Fig. 66. Occurence of Harbour Seals, Nova Scotia.
Boulva and MacLaren (1979)

*HARBOUR SEALS ALSO OCCUR ON SABLE ISLAND.

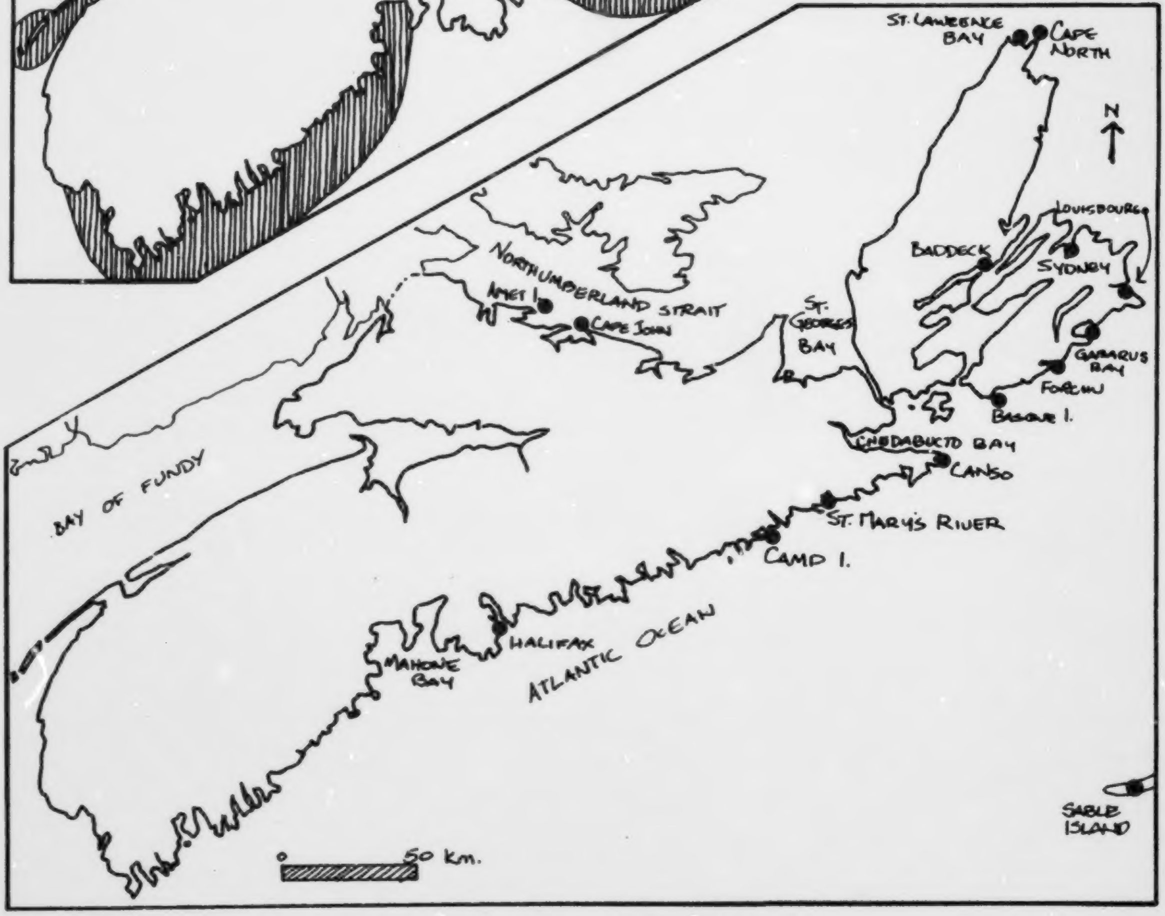
ST. LAWRENCE BAY
CAPE NORTH
N
LOUISBOURG
BADDECK
SYDNEY
NORTHUMBERLAND STRAIT
AMET I.
CAPE JOHN
ST. GEORGES BAY
GABARUS BAY
FORCHU
BASQUE I.
CHEDABUCTO BAY
CANSO
BAY OF FUNDY
ST. MARY'S RIVER
CAMP I.
HALIFAX
MAHONE BAY
ATLANTIC OCEAN
SABLE ISLAND
0
50 km.

Fig. 67. Major Breeding Colonies of Grey Seals.
Mansfield and Beck (1977)

Population Factors The main factors controlling population appear to have been pup predation by sharks. A bounty was paid on Harbour Seals from the 1940's to 1976. Apart from reducing numbers this also had the effect of shifting the seals away from their favoured inshore habitats to rocks and reefs further offshore. Here the surf conditions are usually harsher with the result that more pups are swept away or abandoned. The seals are also more exposed to sharks. Seals are now rarely found in freshwater habitats in Nova Scotia.

GREY SEAL

The Grey Seal is also widely scattered, but breeding takes place in fewer and larger colonies than the Harbour Seal (Figure 67). Again the adults are sedentary but the young wander, often permanently joining another breeding colony, permitting some mixing of local populations. The Grey Seal is often associated with ice and breeding takes place in January and February on islands or on land-fast ice. The Grey Seal is the most important vector of codworm, although this parasite is also found in the Harbour and Harp Seals.

Distribution In Nova Scotia there are three known island breeding colonies: Sable Island and the Basque Islands off the eastern Cape Breton coast, and Camp Island off the Eastern Shore. A major ice breeding colony is found in the Northumberland Strait and George Bay. The movement of the ice northwards towards the Cabot Strait during break-up assists the dispersal of the juvenile seals. In winters when little ice forms in the Gulf many seals resort to Amet Island in the Northumberland Strait. The subsequent overcrowding results in high pup mortality. Many Grey Seals winter in the Bras d'Or Lake, but the pregnant females usually leave to whelp on the shore-ice outside.

Feeding Patterns The Grey Seals favour heavily indented rocky coasts but may also be found feeding in estuaries and lagoons. Their diet is based on benthic skate and flounder and on migrating fish, particularly herring, cod and squid, which they intercept in summer.

Population Factors There appears to have been a marked increase in population since 1962. Possible reasons include the removal of the bounty from Grey Seals in 1949 (the bounty has since been replaced); the reduction in the number of Harbour Seals due to predation by sharks; and a stabilizing of the ice used for breeding in St. Georges Bay and eastern Northumberland Strait caused by the construction of the Canso Causeway.

WHALES, PORPOISES AND DOLPHINS

Twenty species of whales, porpoises and dolphins (Cetacea) are known or may be reasonably expected to occur in Nova Scotia waters. Sometimes they can be seen from land although Nova Scotia cannot rival Newfoundland in terms of whale-watching.

Populations

There is little information on the current numbers of most species, many of which have been greatly depleted by the whaling industry. Although Canada is no longer a whaling nation Sperm, Fin, Sei and Minke Whales are still being exploited in North Atlantic waters. However it would appear that the populations of many marine mammals are now on the increase. This is likely to mean not only more opportunities to watch them, but also more problems with whales and dolphins becoming entangled in fishing nets, and also more strandings.

Distribution

Cetacea are highly mobile, and some species follow a regular pattern of migration. Information from the catch records of Nova Scotia whaling stations suggests that whales may congregate in certain areas rather than being evenly distributed. They appear to be found most often at the edges of the offshore banks, where near-surface zooplankton and fish are more numerous. It is not known whether these whales form discrete local stocks, or if they are in a succession of feeding groups passing through.

Cetacea fall into two sub-orders: the Mysticeti or baleen whales; and the Odontoceti or toothed whales (including porpoises and dolphins). The baleen whales mostly feed on plankton or crustaceans, supplemented by small fish. The toothed whales depend heavily on squid and fish, though some species also eat molluscs and crustaceans. The infamous Killer

Whale has a more varied diet, which includes large baleen whales, seals, walruses, porpoises and dolphins and seabirds.

The whales and dolphins most easily seen in Nova Scotia waters are underlined.

Mysticeti	Fin Whale	Davis Strait to the Caribbean, recorded in the Bay of Fundy and Gulf of St. Lawrence though more common further north.
	Minke Whale	migrate north in spring passing Nova Scotia in May, common in the Gulf of St. Lawrence in summer.
	Sei Whale	Labrador to the Gulf of Mexico, pelagic.
	Blue Whale	Baffin Bay to Panama.
	Hump-backed Whale	summer spent in polar waters, winter near tropics, found closer to shore.
	Atlantic Right Whale	summer Newfoundland to New England, winter around Bermuda.
	Bowhead Whale	Arctic to the Gulf of St. Lawrence (no record in Nova Scotia).
Odontoceti	Bottle-nose Whale	summer in polar waters, moving south to Rhode Island in winter.
	Sperm Whale	cows and calves stay in tropical and temperate waters, bulls wander further north and south; pelagic - water more than 100 fathoms.

White Whale or Beluga	inshore species, large population in the Gulf of St. Lawrence, sightings in Halifax Harbour and St. Margarets Bay.
Common Dolphin	northeast of Newfoundland to tropical Atlantic; pelagic, seldom inshore.
Bottle-nosed Dolphin	temperate and tropical Atlantic, migratory.
White-beaked Dolphin	arctic regions to Gulf of Maine.
White-sided Dolphin	southern Greenland to Cape Cod.
Killer Whale	worldwide, migrate north in spring; not uncommon off Nova Scotia.
Pilot Whale	Greenland to New Jersey, mass strandings occur along coast from Digby to Pictou.
Harbour Porpoise	Davis Strait to New Jersey; common off Maritime coasts in summer; used to be hunted by Micmac in the Bay of Fundy.
Atlantic Beaked Whale	little known
True's Beaked Whale	little known
Pigmy Sperm Whale	little known

PLACES TO SEE WHALES, PORPOISES AND DOLPHINS

Bay of Fundy	Brier Island (district 810) is an excellent place to see Fin and Hump-backed Whales in the summer months, attracted by an area of higher marine productivity over an underwater ledge off the island. Blue and Right Whales can also sometimes be seen there, although they tend to stay closer to the New Brunswick side. Harbour Porpoises can also be seen in the Bay of Fundy.
Atlantic Coast	Whales and dolphins can sometimes be seen in the large bays along the coast. Halifax Harbour is quite often visited by Fin, Minke and Hump-backed Whales, and by White-sided Dolphins in pursuit of shoals of fish.
Gulf of St. Lawrence	Pilot Whales can often be seen during the summer months in St. Georges Bay and along the west coast of Cape Breton.

ASSOCIATED TOPICS

T23 Oceanic Environments, T61 Marine Fishes, T63 Marine Invertebrates

ASSOCIATED HABITATS

H2 Coastal Open Water, H3 Rocky Shore, H4 Boulder Cobble Shore, H5 Sandy Shore

REFERENCES

Boulva and McLaren (1979)
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Mansfield (1967)
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T63 Marine Invertebrates

This topic deals with the occurrence of marine invertebrates in Nova Scotia waters. The marine environment includes the diverse intertidal habitats, such as the salt marsh, sandy beach and rocky shore, as well as the bottom and water of the open sea. The common animals occurring in these habitats are mentioned in the habitat descriptions.

The Canadian Atlantic marine fauna is generally well known as it has been studied for more than a century. Early studies have been listed by Whiteaves (1901) in his catalogue of the marine invertebrates of the region. Marine research in Atlantic Canada has always had a strong relationship with fisheries and to some extent studies of invertebrates for their own sake have been neglected. There has however, been a lot of new information obtained in recent years, through the efforts of the universities and government research agencies.

Diversity

Nova Scotia is almost completely surrounded by water and has three distinct marine areas; Gulf of St. Lawrence, Atlantic coast and Bay of Fundy, which include a wide range of habitats. As a result, the fauna is fairly diverse, though not as diverse as the Cape Cod region at the overlap of warm and cold water fauna regions. A general review of the literature indicates that there are approximately 1,600 species present in the fauna of which at least 400 spend some stage of their life in the plankton. Table 14 lists the main groups with the approximate number of species. In several cases the species numbers are considered to be low.

Distribution

Along the Atlantic coast of North America the fauna can be divided into three main regions controlled largely by water temperature: Sub-arctic, Boreal and Temperate. The Temperate Region lying largely south of Cape Cod is divided into two provinces; Virginian and Carolinian. The Caribbean province lying to the south is Tropical (Figure 68). Although Nova Scotia lies completely within the Boreal Region, the local fauna has associations with all of the Regions mentioned due partly to the nature of post-glacial colonization (T17 Fauna).

Table 14

Numbers of Marine Invertebrates.

Approximate number of species of marine invertebrates recorded from Canadian Atlantic waters.

Group	Approximate Number of Species
Protozoa (Foraminifera, Radiolaria)	less than 300
Porifera (sponges)	400
Cnidaria (medusae, hydroids, sea anemones)	100
Platyhelminthes (flat worms, flukes)	less than 20
Nemertea	10
Aschelminthes	less than 30
Bryozoa and Brachiopoda	30
Polychaeta (Bristleworms)	300
Oligochaeta and Hirudinea (Leeches)	less than 10
Lower crustacea (copepods, barnacles)	200
Malacostraca (shrimps, crabs)	200
Pycnogonida (sea spiders)	20
Mollusca (snails, clams, squid)	150
Echinodermata (starfish, sea urchins)	70
Chordata (salps, tunicates)	40

Warm temperate and Tropical fauna: The larvae of many warm water fish and invertebrates are carried northwards by the Gulf stream, from the southern coast of the United States and the Caribbean. The animals reach the south shore of Nova Scotia in the late summer, through the process of slope water exchange, metamorphose and settle. The occasional occurrence of Blue Crab, Callinectes sapidus and Calico Crab, Hepaticus epheliticus are due to this effect. These populations are generally short-lived as water temperatures are too low for reproduction.

Associated also with the slope water exchange and surface water movements during the tropical storm season are the occurrences of pelagic salps and fauna associated with Gulf Weed, Sargassum spp., including Goose Barnacles, Lepas sp., and Gulf Weed Crab, Planes minutus. These animals may be noticed inshore during August and September from Cape Sable to Halifax.

SPECIAL FEATURES

Changes in the Fauna

Although the distribution patterns of the fauna are reasonably well established, range extensions may be established through new records. Our knowledge of the real range of some species is being improved through research, but some species have been observed to extend their ranges. One is the Common Periwinkle, Littorina littorea that was first detected in Pictou in 1840 and has been progressively reported as it extended southward, eventually reaching the mouth of Chesapeake Bay in 1978. The Green Crab, Carcinas maenas, has been spreading northwards from Cape Cod since about 1900. It reached Halifax in the late 1950's and is still spreading northwards along the Eastern Shore. Significant ecological changes might occur if these species should enter Chedabucto Bay and have the opportunity to enter either the Northumberland Strait or Bras d'Or Lake. The main barrier to this possibility is the cold water area lying off south Cape Breton Island, indicated on the distribution map for Mysis gaspensis, (Figure 69).

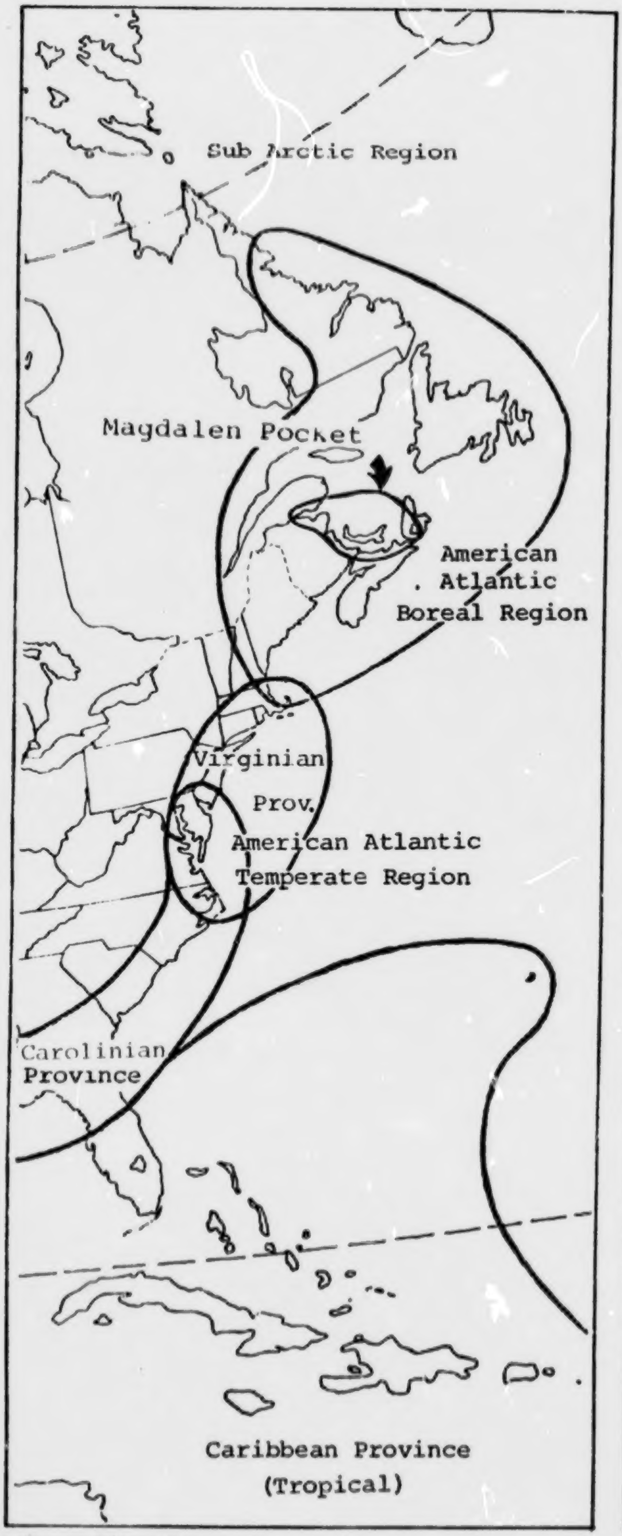
Sub Arctic Region
Magdalen Pocket
American
. Atlantic
Boreal Region
Virginian
Prov.
American Atlantic
Temperate Region
Carolinian
Province
Caribbean Province
(Tropical)

Fig. 68. Faunal regions and provinces of Atlantic North America.

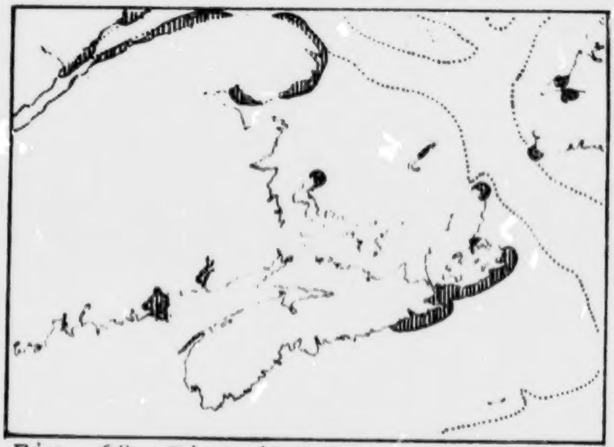

Fig. 69. Distribution of the sub-arctic species *Mysis gaspensis* (Mysid Shrimp).

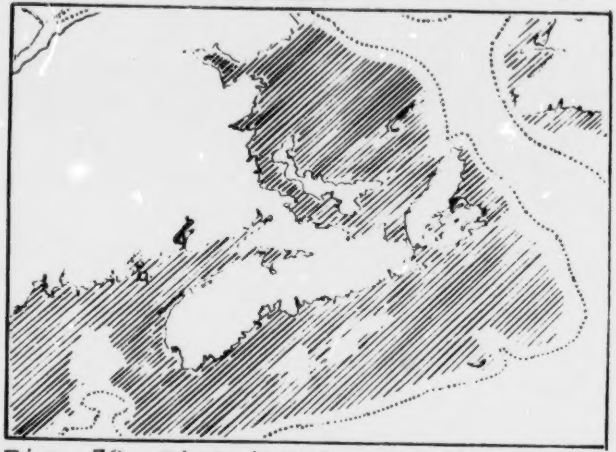

Fig. 70. Distribution of the Boreal species, *Echinarachnius parma* (Sand Dollar).

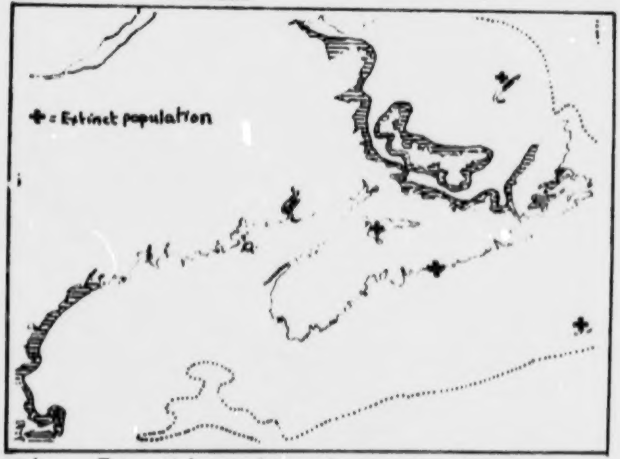
✚ = Extinct population

Fig. 71. Distribution of the temperate species *Crassostrea virginica* (American Oyster).

Sub-arctic Fauna

The sub-arctic fauna is now characteristic of the coast as far south as northern Labrador, but during the ice age it extended along the edge of the ice sheet as far south as Cape Cod. The subsequent withdrawal of cold water and associated fauna to the north left small residual pockets in the Bay of Fundy, northern and southwestern Cape Breton (districts 590, 860 and 870) and the St. Lawrence estuary. An example of subarctic indicator species is the Mysid Shrimp, *Mysis gaspensis* (Figure 69).

Boreal Fauna

The coldwater fauna dominates the region especially in exposed situations and off-shore. The majority of the characteristic species of rocky shores, benthic habitats and plankton belong to this group. The example shown, (Figure 70) the Sand Dollar, *Echinarachnius parma*, occurs from just below low water mark down to 500 feet (150 m), on sandy bottom. Many cold water species occur at depth at the southern end of their ranges.

Temperate Fauna

During the post glacial hypsithermal period, warm water extended northwards along the coast and shelf and into the Gulf of St. Lawrence. At this time a warm water fauna characteristic of the Virginian Province of the Temperate Region occupied the Nova Scotia shoreline. As the temperature cooled towards the present time the warm water fauna was largely replaced by a boreal fauna. However, the temperate fauna remains in shallow water areas of the southern Gulf of St. Lawrence (district 520) and Minas Basin, with pockets in the Bras d'Or Lake (district 560) and in the bays of the Atlantic coast (unit 833). The controlling factor for survival of this "oyster bed" fauna is a summer water temperature in excess of 60°F (15°C). The distribution of the American Oyster, *Crassostrea virginia* is typical for these species (Figure 71). The occurrence of shells, but not living populations, in Minas Basin, Atlantic shore bays, Sable Island and the Magdalen Islands is an indication of the wider distribution of the warm water fauna in the past. The Minas Basin has a warm water fauna that is slightly different from that of the Northumberland Strait, associated partly with the absence of Eel Grass, *Zostera marina*.

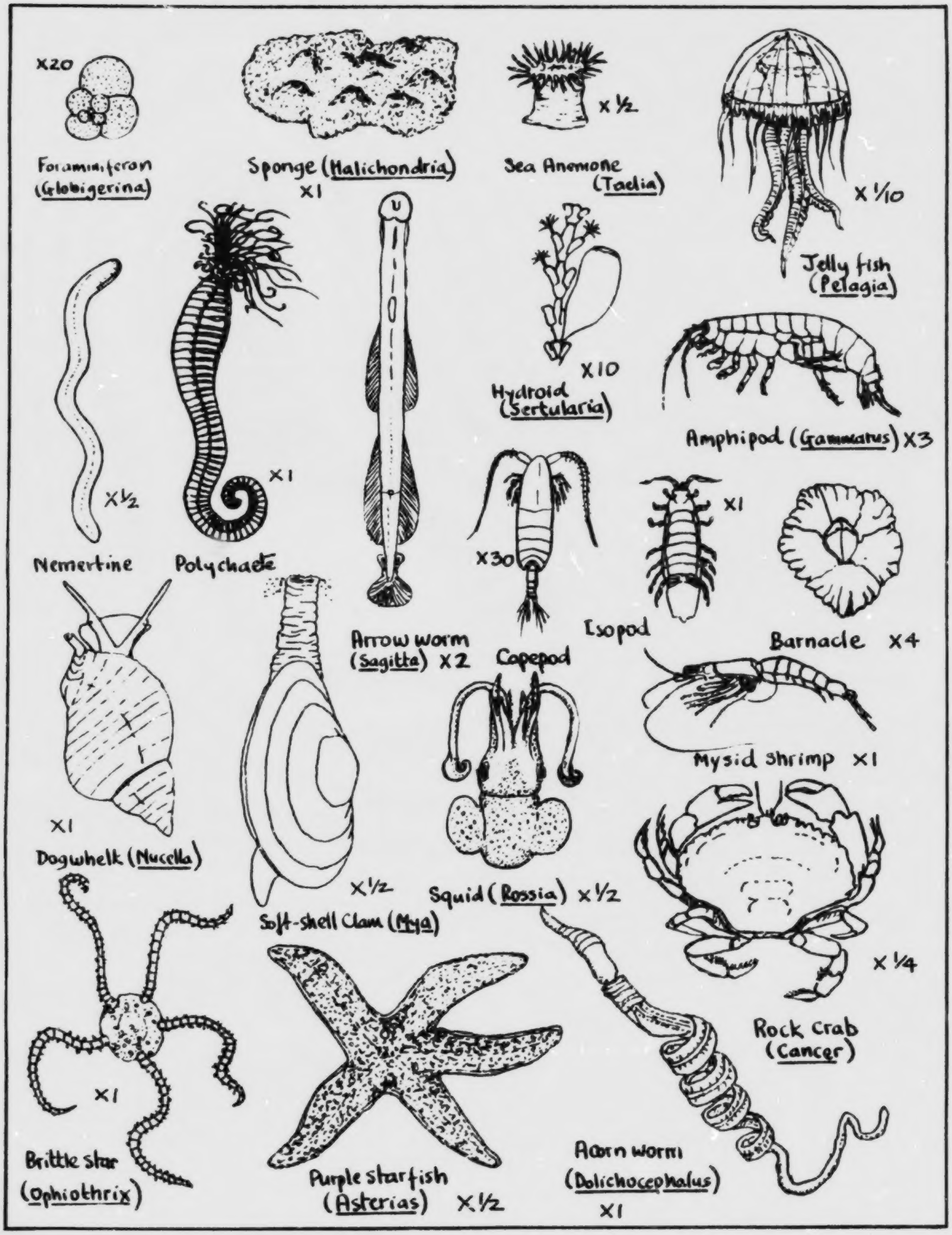
x20
Foraminiferon
(Globigerina)
Sponge (Halichondria)
X1
Sea Anemone
(Taelia)
x ½
Jelly fish
(Pelagia)
X 1/10
Hydroid
(Sertularia)
X10
Amphipod (Gammarus) X3
Nemertine
X½
Polychaete
X1
Arrow worm
(Sagitta) X2
Copepod
X30
Isopod
X1
Barnacle X4
Mysid shrimp X1
Dogwhelk (Nucella)
X1
Soft-shell Clam (Mya)
X½
Squid (Rossia) x½
Rock Crab
(Cancer)
x ¼
Brittle star
(Ophiothrix)
X1
Purple starfish
(Asterias)
X½
Acorn worm
(Dolichocephalus)
X1

Fig. 72. Examples of marine invertebrates found in Nova Scotia waters (Note: enlargements or reductions are approximate).

Rare Species Warm water species occurring in the Northumberland Strait region and in sheltered bays are isolated from main populations further south. The local extinction of any of these species would not be remedied through natural recolonization. The warm water fauna of Minas Basin has a similar situation but with the added factor of the presence of some endemic species recently discovered and being identified. The only Canadian population of the Truncate Borer clam, *Barnea truncata*, a warm water species, occurs in the Minas Basin (region 600).

Jellyfish The only marine invertebrates that are of major concern to people using beaches for recreational purposes are the larger jellyfish. These are all pelagic animals belonging to the Phylum Coelenterata; radially symmetrical animals which possess stinging cells (nematocysts). Only five of the 56 species of jellyfish that occur in Canadian Atlantic waters are known to be harmful to man. These are *Sarsia tubulosa*, *Physalia physalis* (Portuguese-man-of-war), *Cyanea capillata* (Lion's Mane) *Aurelia aurita* (Moon Jelly) and *Pelagia noctiluca* (Mauve Stinger). The Portuguese-man-of-war, rare in Nova Scotia, is found only at the end of the summer season when specimens are blown inshore from the Gulf stream and slope water. The floats are quite visible and when these are seen swimmers can be warned. In most marine areas the other jelly fish are encountered as large numbers of small individuals in the early summer, or fewer, larger individuals in late summer. The severity of the effects of stings varies with the type of jellyfish, length of time in contact with tentacles and condition of health of the victim. (see Shih, 1977).

ASSOCIATED TOPICS

T17 Colonization by Animals, T61 Marine Fishes.

ASSOCIATED HABITATS

H1-2 Offshore Habitats, H3-7 Inter-tidal Habitats

REFERENCES

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Bousfield and Thomas (1975)
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Brunel (1970)
Carlton et al (1981)
Gosner (1971)
Shih (1971)
Shih (undated)
Whiteaves (1901)

HABITATS

Introduction

This section of the Natural History of Nova Scotia deals with the habitats that occur naturally within the province. It is intended to serve both as a guide to recognition and initial investigation of these habitats in the field, and as an integrating link between the Topics and Regional Descriptions. The description of each habitat is, as far as possible, based upon readily visible characteristics, and in addition provides sufficient information for an understanding of the factors that give rise to those characteristics.

The only man-made habitat fully described in the habitat section is Old field as this is a prominent component of many areas of Nova Scotia. However, it is recognized that in certain areas such habitats as cultivated fields, mine tailings and buildings may have local significance. Reference to the influence of man on natural habitats is made where appropriate and general information is provided in section H35.

Definition

Habitat may be simply defined as the place where an organism lives. A complete definition of a particular habitat should recognize all of the interacting abiotic (non-living) and biotic factors that influence the life of the organism. However, in practice certain factors dominate and provide the basis for definition.

When considering the identification of a wide variety of habitat types, as occurs in Nova Scotia, the basic definition will in some cases be dominated by abiotic factors (for example a rocky shore) while in others biotic factors will dominate (for example maple, oak, birch forest). Between these extremes are those habitats that require definition in terms of both abiotic and biotic factors (for example salt marsh). In such cases the vegetation character is strongly qualified by the moisture and mineral content of the soil, availability of nutrients and other factors.

Relationship to Ecological (Biophysical) Land Classifications

Biophysical survey is an integrated method of mapping geology, geomorphology, vegetation and hydrology. The smallest map unit is the land type which is often analogous to habitat as defined here. A grouping of land types, often in a recurring pattern, forms a land system. Land systems are similar but not identical to the units which form the basis of the theme region classification used in the "Natural History of Nova Scotia". A recent inventory has mapped the physical elements of Nova Scotia at the land system level but the land types have never been systematically identified.

Habitats based on vegetation associations closely resemble land types as they have been mapped in Nova Scotia's national parks. Habitats based on a combination of biotic and abiotic factors do not necessarily closely fit the land type definition. At Clam harbour for example, an estuary (a land type) contains the following habitats; coastal fresh marsh, salt marsh, mud flat, sandy shore, rocky shore and open water. On the other hand two land types are combined to form one habitat; the dune system is composed of cranberry marsh and bayberry-white spruce dune land types.

It is hoped that the habitat names defined in this section will prove to be a useful standardized system for identifying and mapping land types as part of Ecological (Biophysical) Land Classifications.

The habitat terminology generally conforms to that used in the Federal/Provincial program for mapping important freshwater wetlands and coastal wildlife habitats. However, the grouping of these habitats as significant Wildlife Habitats more closely resembles the terminology used for Land Districts.

Variations Within Habitats

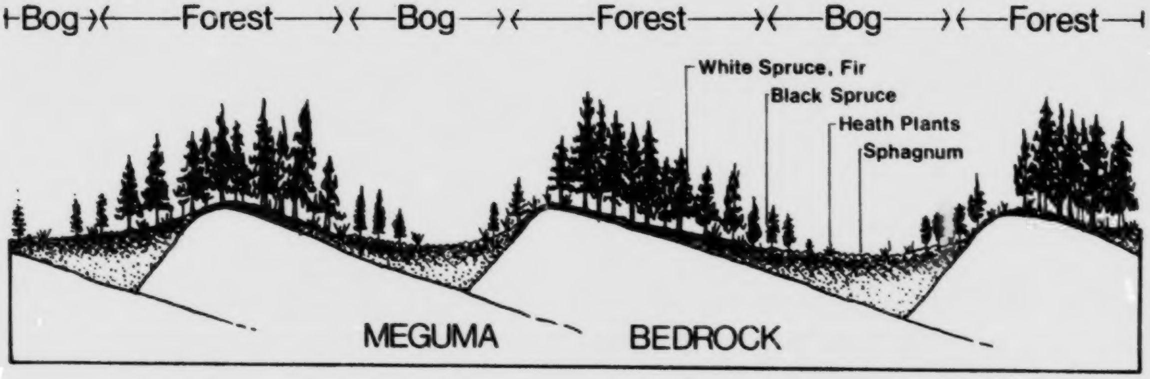
A defined habitat type will normally include a certain degree of variation due to small differences in shade, soil, drainage, etc that may occur. A good example of this is seen within the White Spruce, fir-maple, birch habitat that occurs around the coast, in association with distinct areas of bog and barren. Along the Eastern Shore the parallel ridge and depression structure of the Meguma outcrops results in a sequence of alternating forest and bog habitat on a scale that might not allow the bog to be clearly distinguished in general habitat mapping. In this way small areas of bog habitat are normally found to occur in areas identified as forest habitat (Figure 73).

In addition, within any habitat a diversity of interesting and often clearly defined microhabitats may be found. Examples of microhabitats are the bark of a tree (often a particular level or side of the tree), a rotting log or shaded ground beneath a spruce tree. Each microhabitat will be characterized by small variations in physical, chemical and biological factors. The habitat descriptions refer to microhabitats where relevant, but in general they are beyond the scope of the present work.

Succession

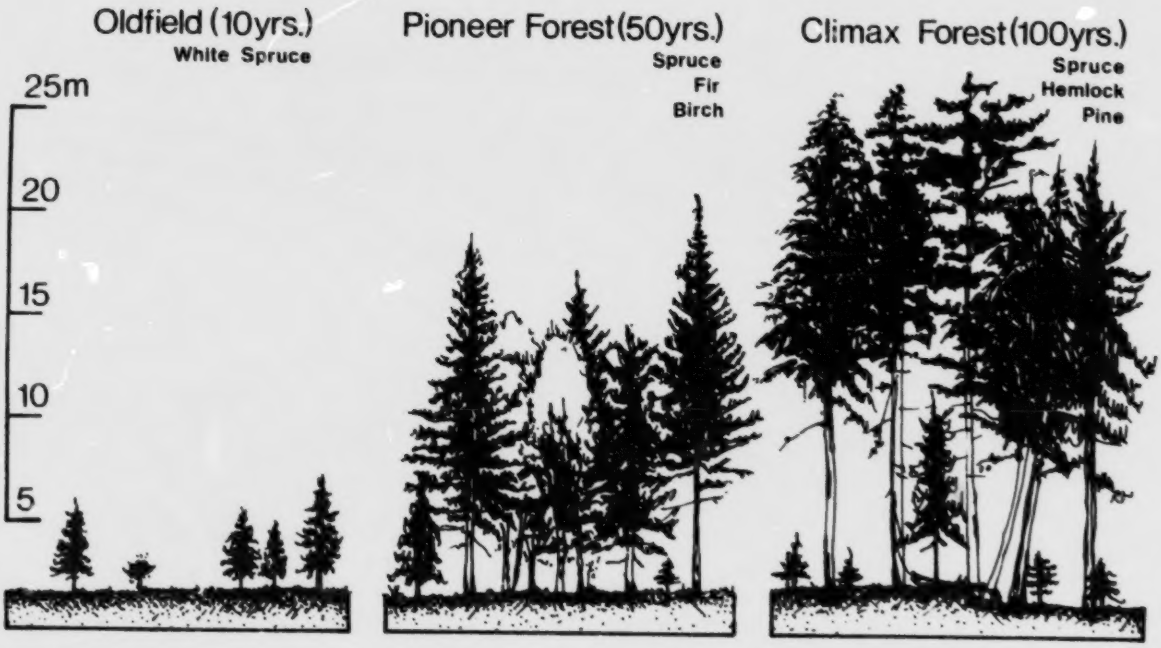
Within any study of habitats it is essential to be aware of the nature of ecological succession (See T45 Successional Trends in Vegetation). In this process an organism or group of organisms progressively alters the conditions in a habitat at a specific site making it more suitable for colonization by other species. In certain habitats, for example a rocky shore, the situation is relatively stable, with the organisms present arranged in fairly distinct zones that reflect prevailing conditions. However, in other habitats the zones indicate stages (known as seres or seral stages) in the successional change from one habitat to another. The aquatic plants at the edge of a pond will progressively grow towards the middle as organic debris from their productivity accumulates. In time the pond converts to a wetland and later to a terrestrial habitat.

The various forest habitats described are often related because they represent seral stages in succession. Some forest types are described as pioneer, representing an early stage in succession on open ground following fire or other form of clearance. The climax forest types represent the last stages in succession where the species maintain the conditions suitable for their own continuance. Figure 74 shows three seral stages in the development of



Bog
Forest
Bog
Forest
Bog
Forest
White Spruce, Fir
Black Spruce
Heath Plants
Sphagnum
MEGUMA
BEDROCK

Fig. 73. A diagramatic cross-section showing the alteration of bog and forest habitats associated with geological structure on the Eastern Shore.



Oldfield (10yrs.)
White Spruce
Pioneer Forest (50yrs.)
Spruce
Fir
Birch
Climax Forest (100yrs.)
Spruce
Hemlock
Pine
25m
20
15
10
5

Fig. 74. Three seral stages in the succession from oldfield to climax softwood forest on a mesic site.

a climax forest on an abandoned field. The nature of the successional process will obviously depend upon the conditions prevailing on the site, particularly climate, soil and moisture. Significant changes are seen when the site is subjected to other factors such as fire. Table 15 provides a system for relating site condition to the dominant species composition of the forest in terms of seral stage. This table may be found useful in understanding the relationships between the forest habitats described.

Ecotone

A clear distinction between different habitats in the field may not be easy in some instances, particularly when trying to draw boundaries, due to areas of transition from one habitat to another. These are known as ecotones. An example is the area of bare rock that lies between the top of the intertidal zone and beginning of terrestrial vegetation. Similarly, the area of transition between an oldfield and pioneer woodland may make it difficult to establish a distinct boundary (Figure 74). Careful examination of ecotones can often provide useful information on the nature and rate of succession on the site. In each habitat description the information on formation and successional sequence should be of use in understanding adjacent ecotone areas.

Ecotones are often important because of their diverse flora and fauna.

Ecosystem

An ecosystem is a system that explains the flow of energy through a community or habitat. It relates various levels of consumer organisms to the primary producers (green plants). When the ecosystem is worked out for a particular habitat it is possible to identify the species that function at each trophic level. This is particularly important where one or two dominant species are responsible for most of the primary production eg. in a low level salt marsh or sand dune.

Plants and Animals

Energy flow may vary significantly in different habitats. For example in a rapidly flowing stream most of the production is exported, whereas in a forest most of the production remains on site as wood or leaf litter. The

SITE	STRUCTURE	SERAL STAGE	HABITAT
Dry	Hardwood	Pioneer	22. Maple, oak, birch.
Dry	Hardwood	Climax	27. Sugar Maple, Yellow Birch, Beech
Dry	Softwood	Pioneer	28. Pine
Dry	Softwood	Climax	-
Dry	Mixed Wood	Pioneer	-
Dry	Mixed Wood	Climax	27. Sugar Maple, Yellow Birch, Beech.
Mesic	Hardwood	Pioneer	-
Mesic	Hardwood	Climax	-
Mesic	Softwood	Pioneer	23. Spruce, fir, pine 26. White Spruce
Mesic	Softwood	Climax	29. Spruce, fir 31. Balsam Fir 25. Spruce, Hemlock, pine
Mesic	Mixed Wood	Pioneer	24. Spruce, fir, pine-maple, birch
Mesic	Mixed Wood	Climax	32. White Spruce, fir, maple, birch.
Wet	Hardwood	Pioneer	15. Fen (-Alder swamp)
Wet	Hardwood	Climax	34. Sugar Maple, Elm, Balsam Poplar
Wet	Softwood	Pioneer	14. Bog
Wet	Softwood	Climax	33. Black Spruce, Larch
Wet	Mixed Wood	Pioneer	33. Black Spruce, Larch
Wet	Mixed Wood	Climax	30. Spruce, fir and maple.

Table 15. Relationships between site, structure, seral stage and Forest habitat type in Nova Scotia. Pioneer (=disturbed site) Climax (=mature), see also Figure 110.

treatment of plants and animals in the habitat descriptions follows clearly the theme of dealing with the common and conspicuous. No attempt has been made to deal with the great species diversity that may exist within each habitat. The plants and animals topics provide a guide to the Nova Scotia species but for detailed information the reader must consult more specialized texts.

In any area, a diversity of habitats and plant species will generally result in a high diversity of animal species. In a forest, the physical structure provides distinct animal habitats in the canopy, midstory, ground flora and soil.

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Smith (1966)

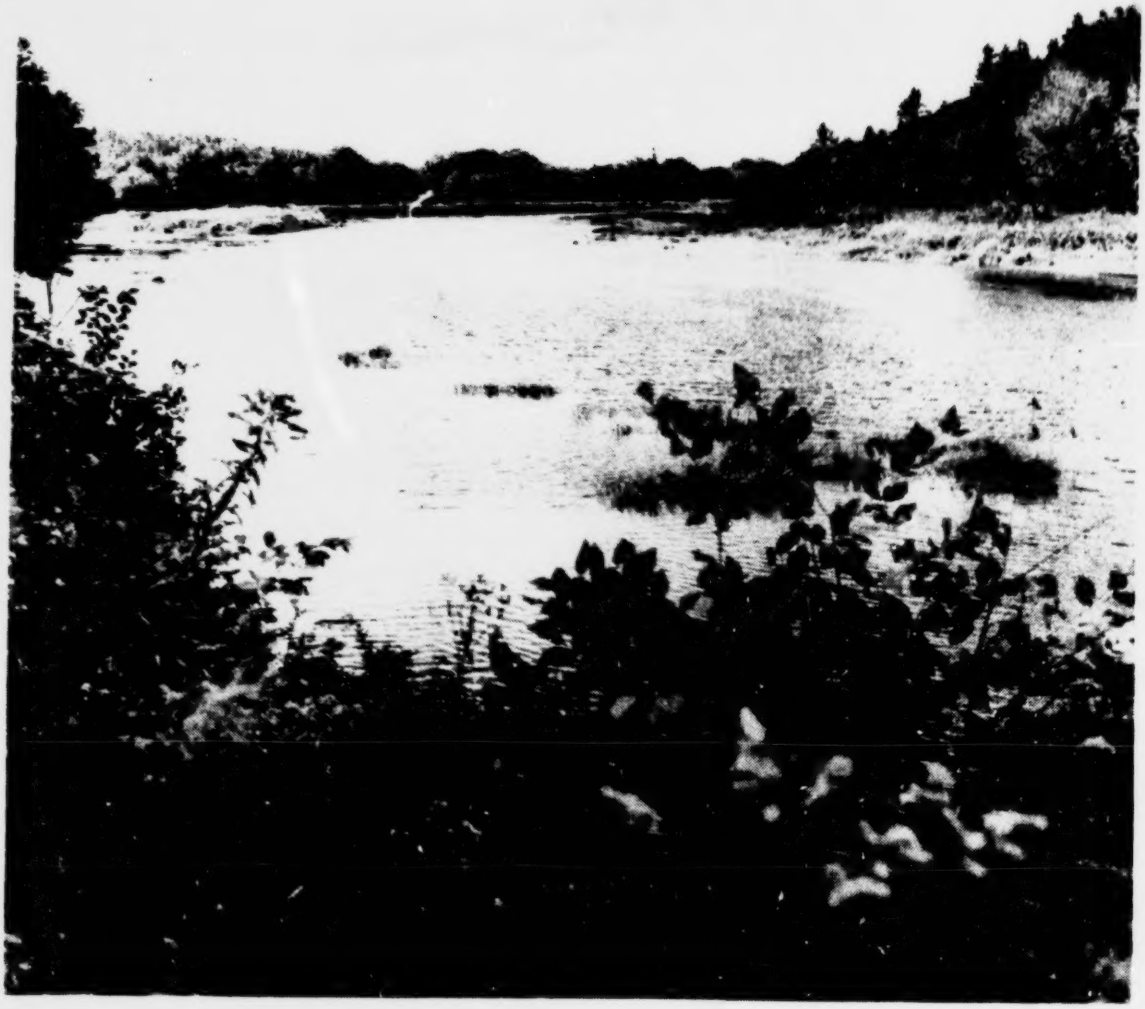

Fig. 75. Habitat diversity in the landscape. St. Marys River, Guysborough Co. The view includes slow moving stream (H12), fen along the riverbank (H15) and spruce, fir-maple forest (H30).
Photo: R. Merrick

COASTAL

H1 Benthic

The sea bottom is composed of a variety of sediment types and water conditions, which support diverse plant and animal communities.

Formation

Benthic habitats dealt with in this section are restricted to those that occur subtidally, from extreme low water mark to the shelf break at 650 feet (200 m) depth. There is no exposure to the air at low tide but there may be influence from wave action and currents. The structure of benthic communities is determined largely by sediment type, in combination with turbidity, depth, temperature, salinity and nutrient level.

Physical Aspects

1. Around the shores of Nova Scotia the benthic habitats are largely influenced by cold water. In the summer, shallow areas such as the upper regions of the Bay of Fundy and Northumberland Strait, are subjected to warmer, lower salinity water. Upwelling and slope-water exchange processes cause local decreases in temperature and increases in nutrient level.

2. The present distribution of bedrock and sediment types; gravel, sand and mud are related to submerged glacial and fluvio-glacial features and contemporary erosion processes. Disturbance of the sediments by tides, bottom currents and wave action may be apparent. The seasonal, on-shore/off-shore movement of sediment in high energy situations is important.

3. The bottom relief, as indicated by water depth, is generally undulating. Off-shore the water deepens to about 650 feet (200 m) in basins and shallows to 175 feet (50 m) on banks.

Ecosystem

The main source of energy in the benthic ecosystem is primary production by the phytoplankton in the water above. In shallow water, primary production by benthic algae is also important and directly supports populations of herbivorous animals. In addition, energy enters the system through particulate organic matter derived from the land and intertidal areas or recycled from the bottom. The particulate feeding animals, filtering water or sorting particles from the sediment are of considerable importance and support several levels of carnivore, including bottom feeding fish such as cod.

Plants

Benthic plants are dependent upon sunlight and therefore only occur in shallow regions where sufficient light penetrates. The depth of light penetration is reduced with increased turbidity as in muddy bays and estuaries. The plant species are almost exclusively algae, including the conspicuous macrophytes commonly grouped as seaweeds. The algae have no roots, but are attached to a firm substrate by a hold fast. The distribution of these plants is therefore also limited by the availability of rock or other firm substrate.

On the Atlantic and Fundy coasts where there is clear, well-aerated water, there are commonly extensive growths of brown and red seaweeds extending from extreme low water mark to a depth of 75 feet (25 m). These include the conspicuous brown kelps such as *Laminaria*, *Alaria esculenta* and *Agarum cribrosum*. Other brown and red algae, some epiphytic on the kelp, also occur including Irish Moss, *Chondrus crispus* and Dulse, *Palmaria palmata*.

In the Northumberland Strait where there are more extreme seasonal temperatures, more turbid waters and erosion by ice in winter, extensive kelp beds do not develop. Subtidal rock ledges are extensively colonized by Serrated Wrack, *Fucus serratus*, *Chondrus crispus* and *Furcellaria lumbricalis*. The latter two species are harvested commercially. In this area seaweed growth becomes sparse below a depth of 30 feet (10 m). In the Bras d'Or Lake seaweeds do not grow below 10-15 feet (3-4 m) depth.

Where seaweed beds have not developed or have been reduced by grazing herbivores and other factors, calcareous red algae, including Lithothamnium are found encrusting rocks, boulders and other hard surfaces. These species can grow in low light intensities and can occur to a depth of 325 feet (100 m) in clear water.

In sheltered bays of the Northumberland Strait and in the Bras d'Or Lake, the seaweed Gracilaria grows in association with Eel Grass.

Eel grass (Zostera marina), a flowering plant with roots, forms dense beds on sandy-mud bottoms in sheltered, shallow bays, all around the coast except for the upper parts of the Bay of Fundy. The development of Eel Grass beds encourages the accumulation of sediment and there are associations with warm-water algae and animals.

Animals

Benthic animals include a wide variety of invertebrate species and fish. They may be conveniently put into two groups:-

Epifauna, that lives attached to (sessile), or roving over (vagrant) the surface of the substrate, and

Infauna that burrows into the substrate. The proportional representation of species of each group at a particular site therefore depends largely upon the nature of the substrate.

Rock and boulders bottoms: These result in a very rough terrain in-shore, but may be relatively smooth off shore particularly where the boulders grade into gravel. The hard surfaces provide no habitat for infauna except where sediment has accumulated in cracks and under boulders. The epifauna species therefore predominate. Attached to the rock surfaces are many species of encrusting sponges, coelenterates, bryozoans and tunicates. Colonies of sufficient size provide habitat for small polychaete worms and crustaceans. There may be individuals of the brachiopod, Terebratulina septemtrionalis, and sea slugs are found associated with the coelenterates.

The bivalves, (*Hiatella arctica* and *Modiolus modiolus*) are usually common. Vagrant species in this habitat are crustaceans including hermit crabs, (*Pagurus*), crabs, (*Cancer*) and lobsters, whelks, (*Buccinum undatum*, *Colus stimpsoni* and *Neptunea lyrata decemcostata*), Sea urchins, starfish and the Sea Cucumber, (*Psolus fabricii*). The brittle starfish, (*Ophiopholis aculeata*), is commonly found between boulders and the Basket Star, (*Gorgonocephalus*), occurs in association with sponges and coelenterates. Because this type of bottom provides suitable habitat for lobsters, many of these animals are commonly taken in lobster traps and may be seen at wharves. Fish such as Sculpin, Cunner, Lumpfish, Wolffish and Pollock are commonly encountered in this habitat.

In shallow water the surfaces of seaweeds may become colonized by epifaunal species, such as particulate feeding worms (*Spirorbis*). Snails may be found grazing on the surfaces of the fronds. The branching holdfasts provide shelter for bivalve molluscs, as well as brittle starfish, small crustaceans and polychaete worms. Sea urchins graze on the seaweeds and are known to be a significant factor in the dynamics of kelp beds. Various types of fish including the Cunner, prey on small animals in the seaweed beds.

Sand and gravel bottoms: Sand may be quite mobile and generally provides a flat terrain. The small particles do not provide a habitat for attached epifauna although small stones and shells of dead molluscs may be colonized by forms typical of the rock and boulder bottom. On sand bottoms the infauna is important. The diversity and abundance of species of polychaete worms, crustaceans, molluscs and echinoderms increases with a gradation towards mud due to the mechanical and nutritional advantages of a sandy/mud habitat. The burrowing fauna includes sea anemones (*Cerianthus*), polychaetes, (*Onuphis conchylega*, *Cistenides gouldii*), the seamouse (*Aphrodite*) and scale worm (*Laetmonice filicornis*), bivalve molluscs, (*Cyclocardia borealis*, *Astarte*, *Arctica islandica* and *Spisula*), with the predatory Moon snail, (*Lunatia heros*).

There are many kinds of starfish, brittle starfish and sand dollars also present and the heart-urchin (*Schizaster fragilis*) occurs on sandy mud in basins. There is also a wide variety of epifauna, especially crabs, hermit crabs, shrimps and scallops, and bottom feeding fish such as skate, plaice, haddock and cod are important.

Beds of Eel grass in shallow water provided habitat for benthic animals which require warm summer temperatures for reproduction and growth. Typical examples are Oysters, Quahogs, snails (*Bittium alternatum*, *Mitrella Lunata*) and crustaceans (*Carcinas maenas*, *Ampithoe longimana*). Typical fish of Eel grass beds are Northern pipefish and Atlantic silverside. Warm water species introduced through slope water exchange during the summer as planktonic larvae, e.g. Blue crab and Striped mullet, are able to grow in the Eel Grass beds but do not normally establish breeding populations.

Mud bottoms: Mud accumulates in relatively still conditions in basins and smaller depressions and provides a flat terrain. The infaunal species are most important and the majority feed on particulate organic matter sorted from the sediment or filtered from the water. These in turn support a variety of epifaunal carnivores and bottom feeding fish. Species diversity and abundance are generally reduced as the mud grades into fine, compacted clay deposits. As on sand bottoms, the occasional stones and shells are opportunistically colonized by epifauna, similar to that associated with rock and boulder bottoms. The mud bottom infauna includes, burrowing sea anemones, sea pens (in deeper water), polychaete worms, burrowing crustaceans such as *Axius seratus*, bivalve molluscs, *Yoldia*, *Nucula*, Tusk shells, *Dentalium*, the gastropod *Aporrhais occidentalis*, sea cucumbers, brittle starfish and starfish. The epifauna of hermit crabs, crabs, shrimps, sea spiders, and the bottom feeding fish are present, as with the sand bottoms.

Distribution
in
Nova Scotia

Benthic marine habitats are found all around the coast of Nova Scotia.

ASSOCIATED TOPICS

T21 to T23 Ocean Characteristics, T26 to T28 Coastal Characteristics, T36 Algae, T61 to T63 Marine Animals.

ASSOCIATED HABITATS

H2 Open Water, H3 Rocky Shore, H4 Boulder and Cobble Shore, H5 Sandy Shore, H6 Mud Flat and H7 Saltmarsh.

REFERENCES:

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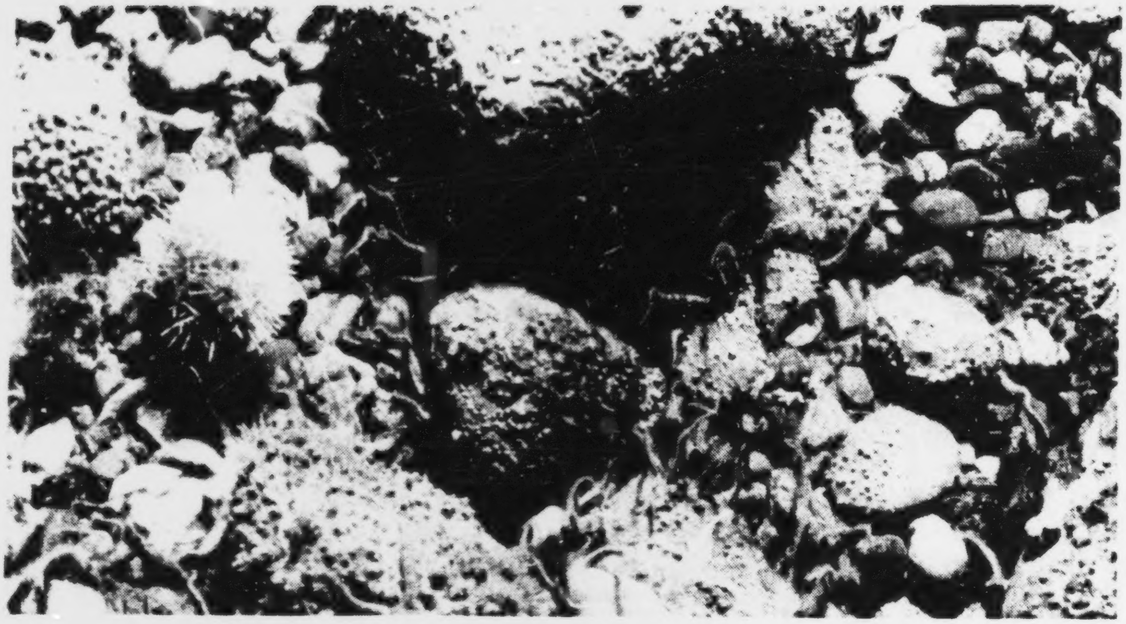

Fig. 76. Marine organisms in a benthic habitat, (H.1) St. Pierre Bank, 40m depth. The gravel is colonized by the red calcareous seaweed, Lithothamnium, hydroids, sea urchins and brittle starfish.
Photo: BIO

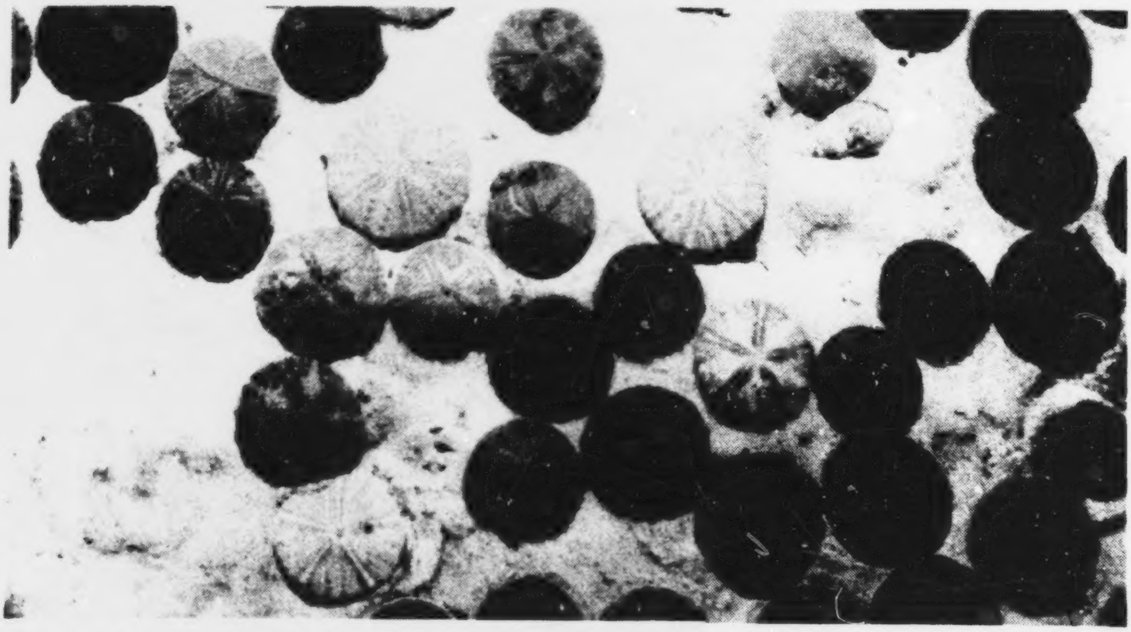

Fig. 77. A benthic habitat (H1) with a sandy bottom showing a spindle shell, and a dense concentration of sand dollars. Banquereau Bank, 60m depth. Photo: BIO

H2 Open Water

The water of the open sea, offshore or contained and modified in bays and estuaries; supports pelagic life.

Formation

Nova Scotia is almost completely surrounded by the open water of the sea. There are four main regions; Atlantic Ocean, Gulf of St. Lawrence, Bay of Fundy and Bras d'Or Lake, each with distinct characteristics. The open water habitat is a primeval part of contemporary landscape.

Physical Aspects

1. Water conditions; salinity, temperature, ice-formation, turbidity, light penetration, tides, currents.
2. Air-water interaction; waves and gas exchange (CO_2, O_2)
3. Land-water interaction; enclosing land forms, freshwater run-off with products of erosion, turbidity and nutrient supply.
4. Bottom-water interaction; turbidity, nutrient supply.

Ecosystem

Primary production is carried out by microscopic plants in the plankton (phytoplankton), utilizing dissolved nutrients derived from the land or sea bottom. The production is markedly seasonal with a conspicuous "bloom" in the spring. Lesser "blooms" occur throughout the summer on the south western coast of Nova Scotia and there is a late summer "bloom" in most regions. This primary production supports diverse species of herbivorous crustaceans, particularly copepods, which in turn support a wide variety of carnivorous pelagic animals and seabirds.

Plants

As there is no firm substrate the plants are almost entirely microscopic algae, occurring in the phytoplankton. Many different species occur, including representatives of the Diatoms, Dinoflagellates, Chrysomonads, Cryptomonads, minute flagellates (nanoplankton) and unicellular reproductive stages of macroscopic algae. Floating seaweeds, including the Sargassum occasionally encountered in connection with slope water exchange, are not characteristic plants of this habitat in Nova Scotian waters.

Animals

Two main groups of pelagic animals are distinguished: Zooplankton where animals have limited powers of movement and are mainly carried by currents, eg. copepods and jellyfish, and Nekton where the animals are active swimmers and commonly have vertical or horizontal migratory behavior, eg. squid, herring, tuna and whales.

The zooplankton itself may be sub-divided into two groups. The animals which spend their whole life in the plankton are collectively known as holoplankton and include immature and adult stages of coelenterates (medusae), Ctenophores (sea gooseberries), Rotifers, pteropods (sea butterflies), polychaete worms (eg. Tomopteris), Cladocera, Copepoda (eg. Acartia, Calanus, Harpacticus and Oithona), Mysids, Amphipods, Euphausiids (Krill), Chaetognaths (Arrow worms) and some Chordates (eg. Salpa). Other animals, grouped as the meroplankton spend part of their life either on the bottom (eg. Coelenterates, Molluscs, Polychaete worms, crustaceans, echinoderms and some chordates (eg. Tunicata) or in the Nekton (eg. herring, squid). These animals include both herbivores and carnivores.

The Nekton includes the largest animals encountered in the open sea, and many are of extreme natural history interest and sometimes high economic importance. All are carnivorous. Examples are squid, herring, mackerel, tuna, sharks, sea turtles, seals and whales. The fishes and squid that occur in deep water off the continental slope are also included in this group.

Special Features

1. Slope water exchange brings warm, nutrient rich water across the continental shelf to the shores of south western Nova Scotia. This feature is especially significant in

mid to late summer supporting local plankton blooms and introducing larvae and adults of warm water invertebrates and fish.

2. Vertical migration of zooplankton and nekton occurs mainly in deeper water along the continental slope. In this process, animals such as shrimp, squid and mesopelagic fish migrate to the surface at night to feed on the plankton. They migrate downwards at sunrise. Although distant from the shore of the Nova Scotia mainland, this process brings a food resource to the surface where it is utilized by whales and ocean birds, eg. Petrels.

3. Paralytic shellfish poisoning is caused by species of phyto-plankton belonging to the Dinoflagellates. In some parts of the world the associated phytoplankton bloom may be sufficient to produce "red-tides". In Nova Scotia waters the bloom of Gonyaulax excavata occurs only in the Bay of Fundy where the high tidal range creates sufficient mixing to prevent a "red tide" developing. However, the toxic dinoflagellates are fed upon by shellfish which accumulate the poison and become dangerous for human consumption. Shellfish beds are usually closed in late summer as a precaution.

4. Enclosed or semi-enclosed bodies of water on the coast, including bays, estuaries and barachois ponds are strongly affected by water run-off from the land, giving low salinities, high turbidity and often high nutrient levels. Also the shallow water may be subject to wider seasonal temperature extremes than experienced in the open sea. There may be vertical stratification of the water and winter ice. These conditions strongly affect the planktonic and nektonic life with total or seasonal exclusion of many species. Extreme cases occur in barachois ponds and the upper reaches of estuaries. Because of access to nutrients primary production may be greater in the summer than in the spring bloom.

Distribution in Nova Scotia

This habitat occurs all around the coast of Nova Scotia and in the Bras d'Or Lake. The following main regions may be distinguished.

1. Northumberland Strait and Cabot Strait (Gulf of St. Lawrence), with high turbidity, warm surface summer temperature, cold winter surface temperature with ice development and intermediate tidal range of 3-5 feet (1.0 to 1.5m). Salinities are in the range 30.0 to 31.0 p.p.t. Jellyfish populations are often conspicuous during the summer.

2. Atlantic Ocean from Cape Breton to Yarmouth (region 800). Low turbidity, surface temperature relatively low in summer, 50°F (10°C) except in bays and where influenced by slope water exchange. Surface temperature low in winter, 33°F (0.5°C) salinities range from 28.0 to 31.0 p.p.t. with lower values in bays and estuaries, relatively little ice development. Tidal range intermediate, 3-6 feet (1.0 to 2.0 m). Influenced by slope water exchange off southern Nova Scotia to give localized, seasonal nutrient enrichment and associated higher phytoplankton productivity. Migratory pelagic fish, eg. herring, mackerel, tuna and sharks and whales, present in the summer. Warm water invertebrates and fish introduced through slope water exchange may be locally present in the late summer.

3. Bay of Fundy, from the Gulf of Maine to Chignecto Bay and Cobequid Bay. High turbidity especially in upper reaches, generally a cold water region with surface temperature of 57°F (14.0°C) in summer and 33°F (0.5°C) in winter. These ranges are more extreme in the upper reaches. Salinity of 31.0 p.p.t. for the Bay of Fundy is reduced to 25.0 p.p.t. or less in parts of the Minas Basin. The tide range is large, 20-45 feet (6 m to 14 m). Phytoplankton productivity is low in the Minas Basin area, but abundant zooplankton species are supported by adequate particulate organic matter. The coast between Yarmouth and Cape St. Mary (district 820) is influenced by cold water upwelling and local nutrient enrichment.

4. Bras d'Or Lake, (district 560) is a many-branched inland sea having moderate turbidity, warm summer surface temperature, 60-68°F (15-20°C), and cold winter surface temperature with extensive ice cover. Surface salinity 20.0 to 25.0 p.p.t. There is no significant tide. Plankton species tend to be estuarine types.

ASSOCIATED TOPICS

T21 to T23 Ocean Characteristics, T26 Coastal Landforms, T27 Shoreline Types, T36 Algae, T54 Seabirds, T61 to T63 Marine Animals.

ASSOCIATED HABITATS

H1 Benthic Communities, H3 Rocky Shore, H4 Boulder and Cobble Shore, H5 Sandy Shore, H6 Mud Flat and H7 Saltmarsh.

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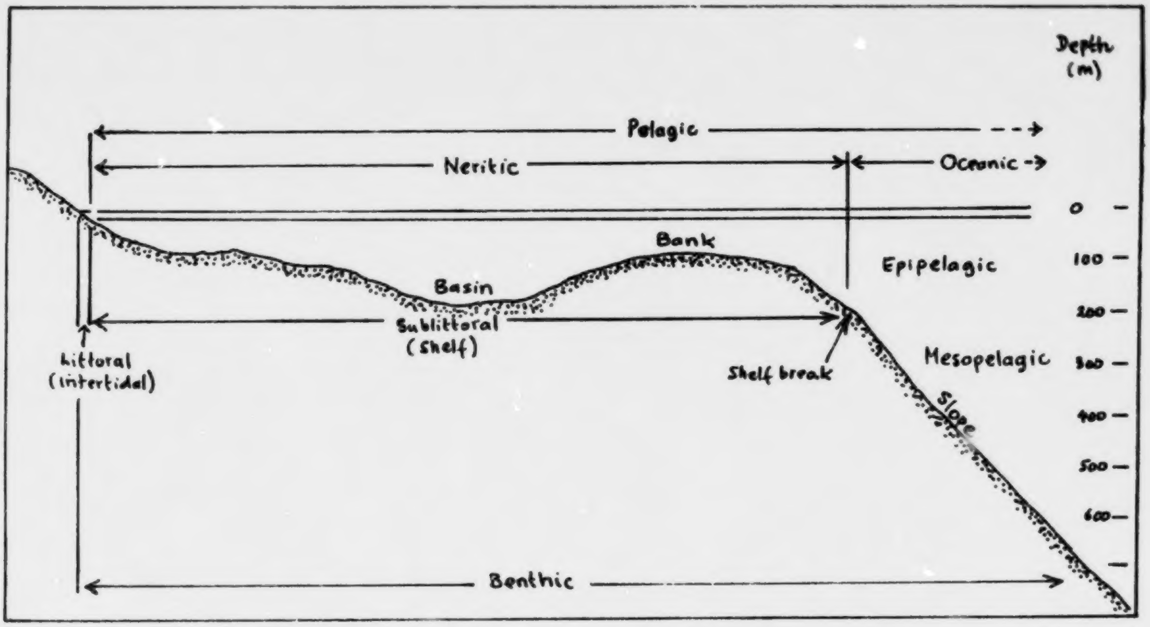
Depth (m)
Pelagic
Neritic
Oceanic
0
100
200
300
400
500
600
Bank
Basin
Epipelagic
Mesopelagic
Sublittoral (shelf)
Littoral (intertidal)
Shelf break
Slope
Benthic

Fig. 78. Terminology used for marine environments on the continental shelf off Nova Scotia.

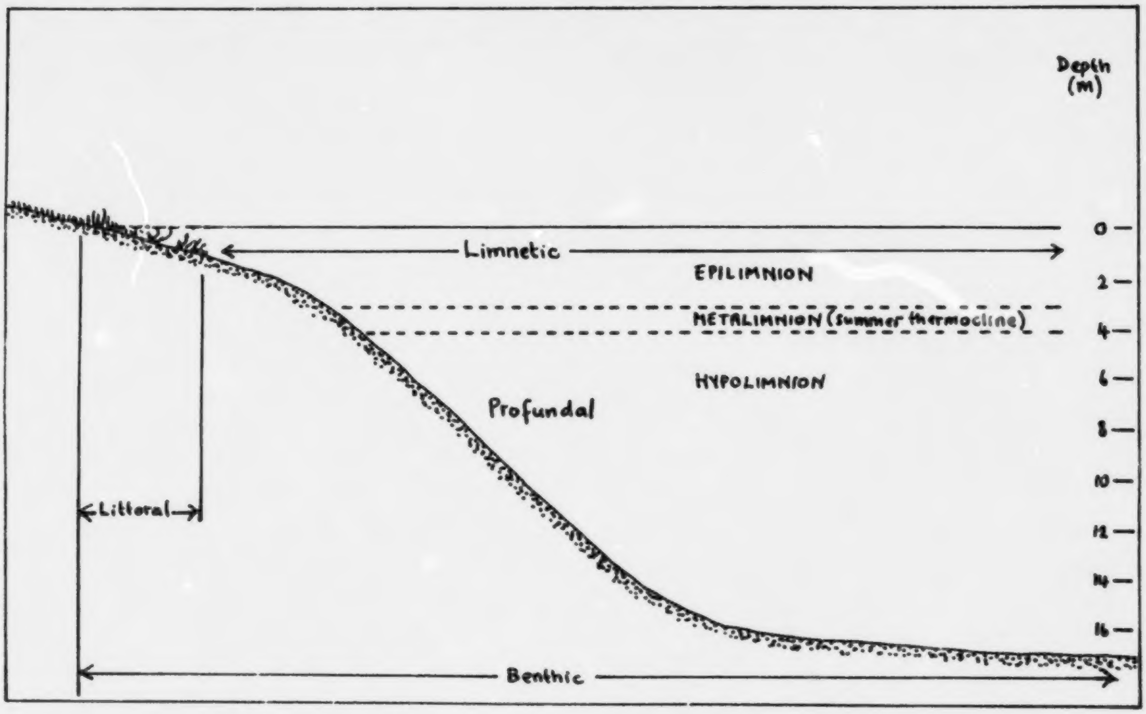
Depth (m)
0
2
4
6
8
10
12
14
16
Limnetic
EPILIMNION
METALIMNION (summer thermocline)
HYPOLIMNION
Profundal
Littoral
Benthic

Fig. 79. Terminology used for freshwater environments in a large lake.

H3 Rocky Shore

Areas of bedrock exposed between the extreme high and extreme low tide levels on the seashore.

Formation

Form as a result of marine erosion of the over-burden and the bedrock due to a combination of rising sealevel and wave action, in areas where there is low sediment supply.

Physical Aspects

1. Bedrock. Resistant bedrock such as granite and quartzite erode slowly and produce steep gradients. Less resistant bedrock such as basalt and sedimentary rocks are commonly eroded into a wave-cut platform with gentle slope.
2. Exposure to wave action, related to dominant wind direction, storms and ocean swell conditions.
3. Tide range determines the area of shore exposed to the air. There is considerable regional variation.
4. Weather conditions, including summer and winter temperature extremes, humidity, precipitation and wind.

Ecosystem

The ecosystem is complex as it is an interaction between terrestrial and aquatic systems. Energy supply is obtained through primary production by seaweeds and phytoplankton and through organic detritus derived from adjacent land and other intertidal habitats (e.g. salt marshes). This energy is directly utilized by a variety of herbivorous and detritus feeding animals on the shore, which are in their turn preyed upon by several levels of carnivore on the shore, and by fish entering the habitat at high tide and terestrial animals, particularly birds, entering at low tide.

Plants

The plants are typically algae and lichens. In sheltered or muddy locations where there is some sediment accumulation amongst the rocks and in tide pools, Cord Grass and Eel Grass also may be found. The seaweeds and lichens are distributed on the shore in horizontal zones that relate to tolerance of the species to either exposure to air (seaweeds) or submergence in water (lichens) during the tidal cycle. Conspicuous plants are as follows:

Splash Zone: (above the extreme high water mark but reached by storm waves) generally bare of vegetation though there may be grasses growing in cracks of rocks and somes patches of lichens (Xanthoria parietina).

Upper Shore: (rocks bare at the top but below the level of high water of spring tides) There are algae e.g. Codiolum sp., Calothrix crustacea and lichens (Verrucaria sp.)

Middle Shore: Dense growth of brown Rockweeds Ascophyllum nodosum, and Fucus spp. The red seaweed Porphyra and Fucus serratus are common in some places. Green seaweeds such as Cladophora sp., and epiphytic Polysiphonia lanosa on the Ascophyllum plants, also occur.

Lower Shore: Below the dense rockweeds there is a conspicuous zone of Irish Moss (Chondrus crispus) and calcareous algae (Lithothamnium sp. and Corallina officinalis). Below this the kelps Laminaria sp. are present but only visible at low water of spring tides. This zone continues into the sub-littoral benthic habitat (H.1).

The seaweed growth is usually well developed on all rocky shores but is best in exposed, clear water conditions, on the Atlantic coast and lower reaches of the Bay of Fundy. On the Northumberland Strait and upper regions of the Bay of Fundy, ice action and turbidity limit the seaweed growth.

Animals: The animals include marine benthic epifauna tolerant to various lengths of period of exposure to the air at low tide, and vagrant terrestrial species. A system of horizontal zonation of the aquatic fauna is apparent.

Upper Shore: On the bare rock surfaces there are very few animals present except the Rough Periwinkle.

Middle Shore: At the top there is a conspicuous zone of Barnacles which is limited at its lowest extent by the growth of Rockweed. There is a variety of herbivorous animals including Rough Periwinkles, Smooth Periwinkles, Common Periwinkles and amphipod crustaceans. Sessile species include Hydroids (Sertularia sp) and Blue Mussels. The Green Sea Urchin is found at lower levels. Carnivores, feeding mainly on the molluscs are Dog Whelks and Purple Starfish.

Lower Shore: Lower down the shore the diversity of animals increases as more species are tolerant to the shorter period of exposure at low tide. This is particularly true where animals can find shelter under rocks or seaweeds. Herbivores include Common Periwinkles, Limpets, Green Sea Urchins, isopods and amphipods. The sessile particulate feeders include sponges, hydroids, tube worms (Spirorbis sp. on seaweeds), Horse Mussels, brittle starfish and tunicates. The carnivores include Sea Anemones, Scale Worms, Purple Starfish, Rock Crabs and Sea Slugs. On sedimentary rocks of the Minas Basin and Northumberland Strait rock-boring bivalves Petricola pholadiformis, Zirphaea crispata and Barnea truncata are locally important. Vagrant terestrial species, insects, birds and mammals enter the rocky shore habitat at low tide to feed. Several shore bird species feeding on rocky shores include Ruddy Turnstones, and Herring Gulls are also typical. (Sea Urchins found above high water mark are evidence of their feeding.)

Special Features

1. The local modification of plant and animal zonation related to the tide range, exposure, ice action, and other factors prevailing. Considerable regional variation is seen. Some examples of zonation are shown in the diagram (Fig. 78)
2. Tide Pools. Where water is retained in depressions or cracks in the bed rock during the low tide period, the plants and animals are not subjected to dessication. As a result these pools often exhibit rich growths of organisms normally associated with the lower shore and subtidal habitats. Large pools are not strongly

influenced by air temperatures but smaller pools, particularly if located at high levels on the shore where they may not be flushed out by neap tides, experience wide ranges of temperature and salinity. In these conditions only hardy algal species such as Enteromorpha intestinalis can occur.

Distribution in Nova Scotia

Rocky shores occur all around the coast of Nova Scotia but vary in their character according to the physical aspects that prevail. Rocky shores in the upper region of the Bay of Fundy are strongly influenced by mud and ice action and have poor seaweed growth. Different examples of rocky shores are found in the lower regions of the Bay of Fundy with the wave-cut platform of the basalt bedrock and large tide range and on granite and quartzite headlands of the Atlantic Coast. In Cape Breton and the Northumberland Strait soft sedimentary rocks, small tide range and winter ice action result in relatively poor rocky shore development. There is no intertidal zone in the Bras d'Or Lake.

ASSOCIATED TOPICS

T15 to T17 Colonization, T21 to T23 Ocean Characteristics, T24 Coastline Modifying Forces, T26 Coastal Landforms, T27 Shorline Types, T36 Algae, T52 Shorebirds, T61 to T63 Marine Animals.

ASSOCIATED HABITATS

H1 Benthic Communities, H2 Open Water, H4 Boulder and Cobble Shore, H5 Sandy Shore, H6 Mud Flat and H7 Saltmarsh.

REFERENCES

Bousfield and Laubitz (1972)
Davis (1972 a, b, c and d)
MacFarlane and Milligan (1966)
Stephenson and Stephenson (1954)
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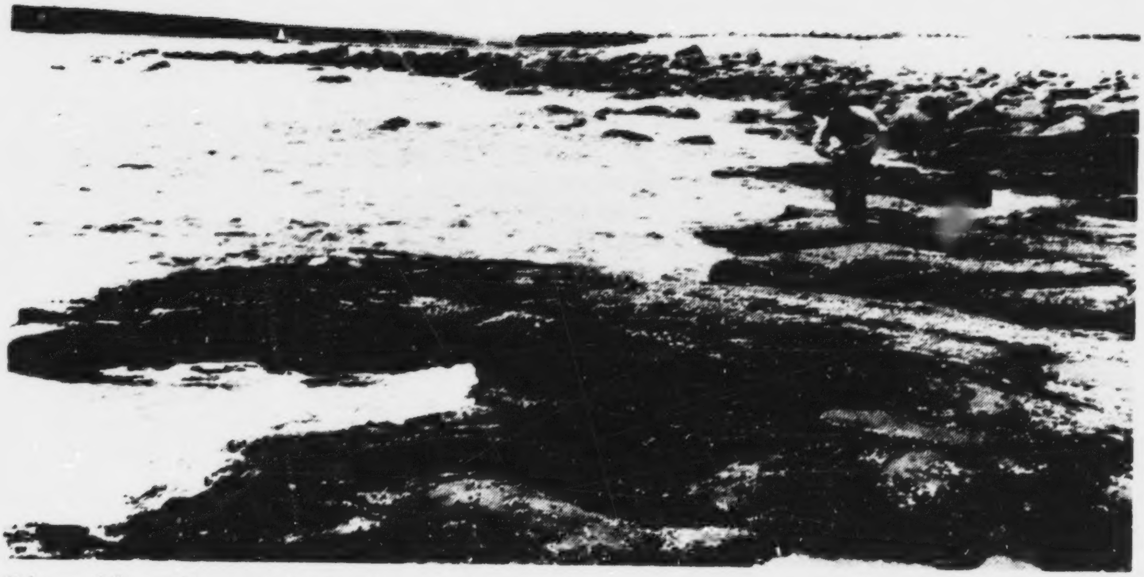

Fig. 80. Exposed Rocky Shore (H3) seen near low water with a tide pool in the foreground. In the background is a cobbly shore (H4). Mouth of St. Mary's River, Guysborough Co.
Photo: D.S. Davis

Fig. 81. A sandy shore (H5) at Caribou Island, Pictou Co. In the background is a sea cliff (H19) and rocky shore (H3). Photo: R. Merrick

H4 Boulder, Cobble Shore

Areas of boulders and cobbles exposed between the extreme high tide and extreme low tide marks.

Formation

Where there is erosion of glacial till on headlands and islands. In high energy situations the cobbles may form a storm beach at and above high tide mark. In intermediate and low energy situations the boulders rest on a wave-cut platform.

Physical Aspects

1. Boulders provide a relatively stable hard substrate. Cobbles and gravel are usually mobile.
2. Exposure to wave action, related to dominant wind direction, storms and ocean swell conditions. In high energy situations the boulders and cobbles are mobile, limiting colonization by intertidal organisms.
3. Tide range determines the area of shore that is exposed to the air.
4. Water conditions including summer and winter temperature extremes, formation and movement of ice, turbidity and salinity.
5. Air conditions, including summer and winter temperature extremes, humidity, precipitation and wind.

Ecosystem

Primary production within the habitat is limited to the seaweed growth, which is very limited or absent in exposed situations. Energy also enters the system through primary production in the plankton and through suspended organic detritus derived from the land and adjacent intertidal habitats. There are herbivores and detritus feeders in the epifauna, but populations are often small. These animals are preyed upon by carnivores, including birds.

Plants

Mainly algae (seaweeds) which colonize the surfaces of boulders. In intermediate and low energy situations there is horizontal zonation related to the period of exposure at low tide. On the upper shore where the cobbles are easily moved by wave action there is no seaweed growth, but some lichens and flowering plants occur above the high tide mark. On the Middle shore, in sheltered conditions there is a narrow black band of algae and lichens below which brown seaweeds, *Fucus* sp. and *Ascopyllum nodosum* are conspicuous. Various filamentous algae are present in the spring time. Cord-grass may be found growing in mud and gravel between the boulders at lower levels. In more exposed situations the seaweed growth is limited by the movement of the boulders and cobbles. Where seaweeds do occur there is usually a sparse growth of the brown seaweeds with Irish Moss (*Chondrus crispus*) and the calcareous species *Corallina officinalis* and *Lithothamnium* sp. in the lower zone.

Animals

The movement of boulders and cobbles in high energy situations severely limits colonization by animals. In low and intermediate situations Barnacles, isopods, amphipods, Green Crabs, periwinkles, Dog Whelks, Blue Mussels and Purple Starfish are often present.

Special Features

On exposed, high energy shores the cobbles are often washed up to form a storm beach or berm feature. As they are largely beyond the reach of wave action the cobbles are more stable and become colonized by encrusting lichens and flowering plants such as Sea-lungwort and Beach pea. Animal life is limited to various species of amphipods and fly larvae, which feed on decaying seaweed cast up by storms. Spiders and birds prey upon these animals.

Distribution in Nova Scotia

Whole coastline but best developed along the Atlantic coast where there is sufficient glacial till source material. In St. Margaret's Bay and Mahone Bay (district 460) for example, eroding drumlins have boulder and cobble beaches with varying degrees of exposure. The islands eventually erode away to leave boulder reefs only visible at low tide. Sheltered boulder beaches occur at the head of inlets, such as in Head Harbour.

ASSOCIATED TOPICS

T21 to T23 Coastal Waters, T26 Coastal Landforms, T27 Shoreline Types, T36 Algae and T53 Shorebirds.

ASSOCIATED HABITATS

H1 Benthic Communities, H2 Open Water, H3 Rocky Shore, H5 Sandy Shore, H6 Mud Flat, H7 Saltmarsh, H9 Dune System, H17 Barren, and H19 Cliff.

REFERENCES

Davis (1972 a, b, c and d)
Stephenson and Stephenson (1954).

H5 Sandy Shore

Areas of sand exposed between the extreme high tide and extreme low tide marks.

Formation	Sandy shores form through the deposition of sand resulting from the erosion of glacial till and bedrock in the area of occurence.
Physical Aspects	1. The substrate includes particle sizes ranging from fine gravel to sandy-mud. In sheltered conditions the mud content increases and reduced drainage, results in anaerobic conditions just below the surface. In exposed conditions the sand is often mobile, well-drained and well aerated. 2. Exposure to wave action, related to dominant wind direction, storm and ocean swell conditions, and influence of tidal and long-shore currents. 3. Tide range determines the area of shore that is exposed to the air. 4. Water conditions, including summer and winter temperature extremes, formation and movement of ice, turbidity and salinity. 5. Air conditions, including summer and winter temperature extremes, humidity, precipitation and wind.
Ecosystem	There is no significant primary production except by blue-green algae and diatoms that occur on the surface of sandy mud in sheltered conditions. Energy input into the system is from the phytoplankton in the water and from particulate organic matter (detritus) derived from the land and adjacent intertidal habitats. Herbivorous and detritus feeding and carnivorous animals are included in the sand infauna. Other carnivores include vagrant fish and birds.
Plants	Due to the mobility of the substrate, plant life is very limited in both diversity and abundance. Seaweeds are absent, but diatoms and blue-green algae may be common in

sheltered, sandy-mud conditions. *Ulva* and *Enteromorpha* develop in summer on many sandy-mud flats. Also, in these conditions some Cord-grass and Glasswort may occur as a first stage in saltmarsh succession. On exposed shores, wind-blown sand accumulates above high water mark as dunes, and pioneer beach plants such as American Beach Grass and Sea Rocket may occasionally be subjected to waves or spray.

Animals

As there is an absence of any hard substrate, the infauna species predominate. Distribution and abundance are controlled largely by the tide level and mobility of the sand. At low tide levels the sand seldom dries out, but is mobile due to currents and wave action. Animals have to burrow to maintain their position on the beach.

On exposed beaches polychaete worms (*Dispio uncinata*, *Nephtys bucera*) and molluscs (*Tellina agilis*, *Spisula solidissima*, *Ensis directus* and *Lunatia heros*) occur at low tide level. Isopod and amphipod crustaceans (*Chiridotea caeca*, *Haustorius canadensis*) also occur at the mid and low tide levels. At the high tide mark amphipods (*Talorchestia* sp) are common feeding on organic matter in the drift line, and overlap in their occurence with insects including the larvae of flies and beetles.

Where the sand grades into sandy-mud in sheltered conditions the fauna increases in both diversity and abundance. Ribbon worms (*Cerebratulus* sp.), polychaetes (*Nereis* sp. and *Nephtys* sp.), bivalves (*Mya arenaria*, *Macoma balthica*) and Mud Snails (*Nassarius Ilyanassa*) are typical. Where patches of gravel occur on the lower shore, clumps of Blue Mussels are found with associated Barnacles and other epifauna.

Sandy shores provide important feeding grounds for a variety of shore birds including Sandpipers and Plovers. Flounders and other fish come into feed at high tide.

Special Features

1. There is usually seasonal variation in the distribution of sand on the shore due to wind and wave action. Sand is transferred from the beach to shallow water in the

winter and is returned in the summer. This mobile sand can build up as well-drained bars that dry out at low tide and which support few animals.

2. Sand shores are the best localities for beach-combing and shell collecting during the summer. Because of the on-shore movement of sand it is possible to find shells of species that live offshore.

Distribution in Nova Scotia	Whole coastline of Nova Scotia, with best development along the Atlantic and Northumberland Strait coasts and Minas Basin.

ASSOCIATED TOPICS

T21 to T23 Coastal Waters, T26 Coastal Landforms, T27 Shoreline Types, T53 Shorebirds and T63 Marine Invertebrates.

ASSOCIATED HABITATS

H1 Benthic Communities, H2 Open Water, H3 Rocky Shore, H4 Boulder and Cobble Shore, H6 Mud Flat, H7 Saltmarsh and H9 Dune System.

REFERENCES

Davis (1972 a, b, c and d)
Tufts (1973).

H6 Mud Flat

Areas of mud and sandy-mud exposed between the extreme high tide and extreme low tide marks.

Formation	Mud flats form from the deposition of mud in sheltered tidal water, particularly in estuaries where there is a large sediment supply.
Physical Aspects	1. substrate is of fine particles, from fine sand to silt, and often compacted into clay. Drainage is poor and anaerobic conditions exist just below the sediment surface. 2. Exposure to wave action, related to wind and tidal and long-shore currents. The surface sediment is mobile in moderate waves. 3. Tide range determines the area of shore that is exposed to the air. 4. Water conditions, including summer and winter temperature extremes, formation and movement of ice, turbidity and salinity. 5. Air conditions; including summer and winter temperature extremes, humidity, precipitation and wind.
Ecosystem	Primary production is limited to diatoms and other microscopic and filamentous algae and to Cord Grass. Most energy enters the system from the plankton or as organic detritus derived from the land or adjacent saltmarshes. The detritus and associated bacteria are consumed by large populations of bivalve molluscs, amphipods and polychaetes. These are in turn eaten by carnivores, particularly migratory shore birds.
Successional Sequence	1. In sheltered areas, the deposition of sediment on the shore will eventually raise the level so that seeded or ice transported Cord Grass may become established.

2. The Cord Grass expands from the point of colonization by vegetative means and accelerates the rate of sediment deposition (Low Marsh).

3. When the substrate of the marsh rises to mean high water mark through the accumulation of sediment the Cord Grass gives way to Marsh Hay and associated plants (High Marsh).

4. With further sediment deposition the vegetation becomes mainly freshwater, cattail, rushes and reeds, possibly in association with spruce (swamp).

Although saltmarshes lie adjacent to sand dune, cobble beach or fen habitat there is no successional association even though this may be apparent. Saltmarshes may become completely smothered by sand or mud which may in time provide the basis for a new saltmarsh.

Plants

Plants are limited to microscopic algae (Diatoms) and filamatous algae on the sediment surface and occasionally seaweeds such as Fucus spp attached to stones. Some Cord Grass (Spartina alterniflora) is found at the first stage of saltmarsh succession.

Animals

Animals are predominantly detritus-feeding infauna, that can tolerate exposure at low tide and the mechanical difficulties of living in mud. Polychaete worms (Spiothanes wigleyi: Clymenella torquata), amphipods (Corophium volutator) and bivalves (Mya arenaria, Macoma balthica) are particularly common. Scavengers and carnivores present are polychaetes (Neanthes virens), crustaceans (Chiridotea caeca, Crangon septemspinosus) and molluscs (Nassarius obsoletus, Lunatia heros).

Sessile epifauna species such as barnacles and slipper limpets (Crepidula fornicata) occur attached to small stones lying on the mud surface. Flounders and other fish species come on to the mud flats to feed at high tide. Mud flats are also important feeding areas for migratory shore birds such as the Semi-palmated Sandpiper, and land mammals particularly Raccoons.

Special Features	1. The large numbers of a few species of benthic infauna depending upon a diet of organic detritus. Examples of population densities are 700,000/square foot (63,000/m^2) for *Corophium volutator* and 40,000/square foot (3,500/m^2) for *Macoma balthica* . These animal populations support large flocks of migrating shore birds during the late summer. The Semi-palmated Sandpiper is the most important, with a population of over 280,000 in the Bay of Fundy area. This is an important ecological feature of Nova Scotia. Migratory fish also visit to feed on the benthic (eg. *Corophium*) and epibenthic species (eg. *Neomysis*, *Mysis*, *Crangon*).
Distribution in Nova Scotia	Mud flats occur in all inlets and estuaries around the coast of Nova Scotia, but the best examples are in Minas Basin, Cobequid Bay and Cumberland Basin.

ASSOCIATED TOPICS

T21 to T23 Coastal Waters, T26 Coastal Landforms, T27 Shoreline Types, T52 Shorebirds and T61 to T63 Marine Animals.

ASSOCIATED HABITATS

H1 Benthic Communities, H2 Open Water, H3 Rocky Shore, H4 Boulder and Cobble Shore, H5 Sandy Shore and H7 Saltmarsh.

REFERENCES

Risk, Yeo and Craig (1977)

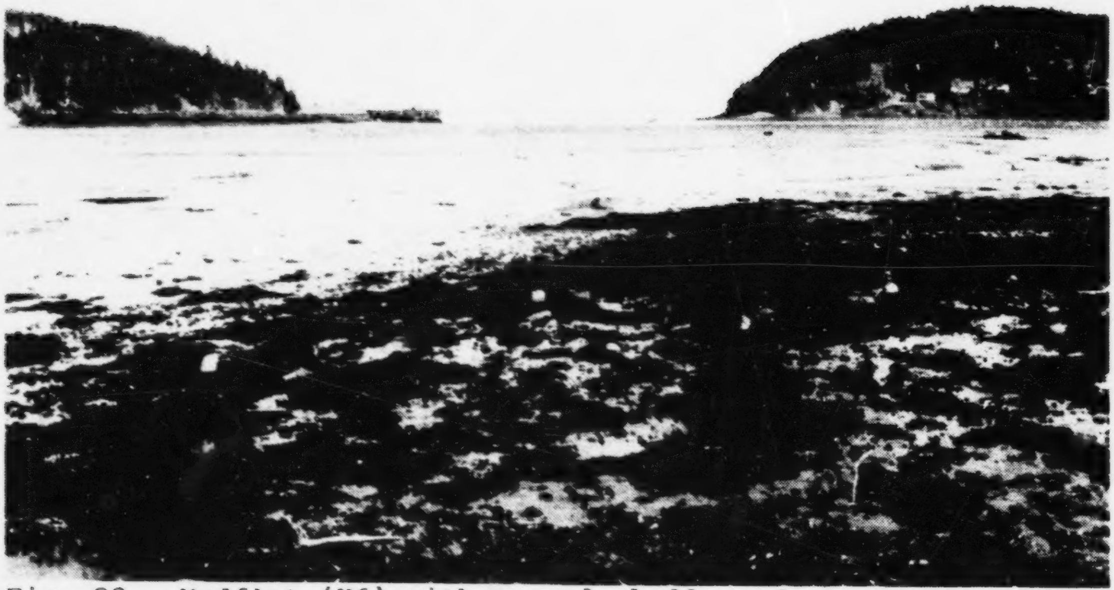

Fig. 82. Mudflat (H6) with mussel shells and stones colonized by *Fucus* in the foreground. The forest is coastal white spruce, fir-maple, birch (H32). Sandy Cove, (St. Mary's Bay) Digby Co.
Photo: R. Merrick

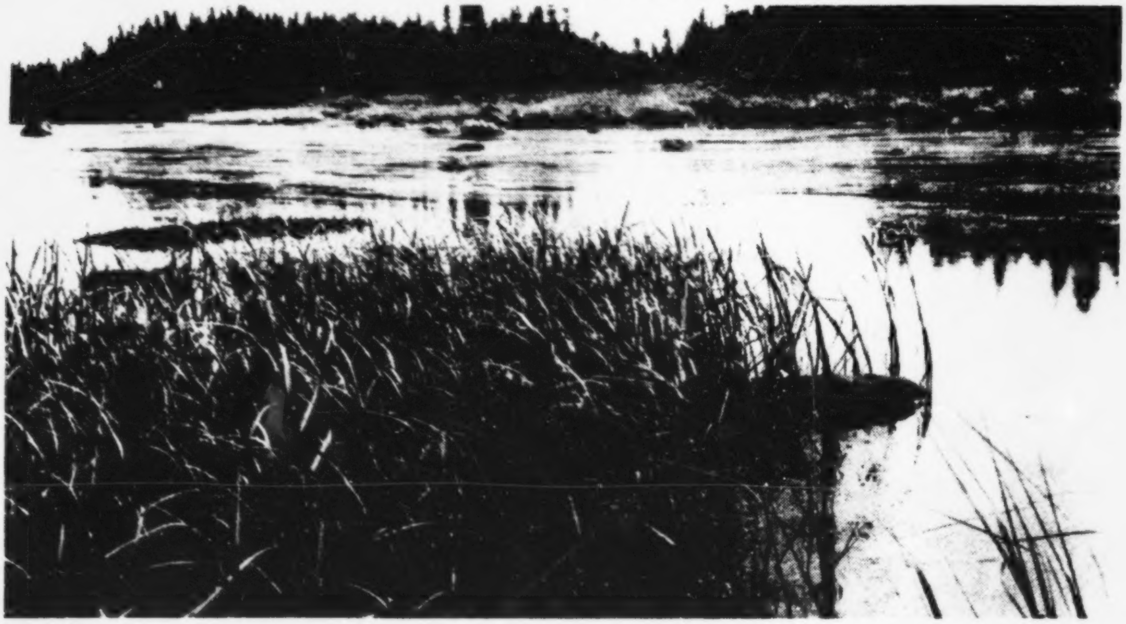

Fig. 83. Saltmarsh (H7), showing Cord Grass (*Spartina alterniflora*), St. Mary's River, Guysborough Co.
Photo: D.S. Davis

H7 Saltmarsh

A marine, intertidal area with soft substrate, colonized by salt tolerant vegetation; predominantly grasses. Also known as tidal marsh.

Formation

Saltmarshes generally form on stable or emerging coastlines in the following sheltered situations:

1. estuaries,
2. in the shelter of spits, bars or islands,
3. in protected bays.

They only form on submerging coasts when the rate of sedimentation exceeds the rate of submergence. The initial colonization of the upper level of sand or mud shores accelerates the accumulation of sediment, resulting in successional development of the habitat (see below).

Physical Aspects

Bedrock: is not significant as it is usually deeply buried beneath the marsh soil. However, soft bedrock in the general area (eg. sandstones in Bay of Fundy, region 600 and Northumberland Strait, district 530) may contribute to the sediment supply necessary for marsh construction. On the Atlantic coast most sediment is derived from eroding till deposits (district 830).

Soils: The saltmarsh will develop its own soil on a base of sand or mud. This soil is stonefree and includes a reasonably large amount of organic material. Anaerobic conditions in the soil result from poor drainage.

Relief: low, usually a gradual slope deeply cut by drainage channels.

Drainage: poor due to the nature of the soil, at least partly covered by each flood tide, mostly surface run-off.

Exposure: as mentioned above salt marshes only occur in sheltered locations without significant wave action.

Water conditions: In sheltered bays and, particularly in estuaries water conditions are extremely variable. Temperatures and salinity vary seasonally and range from the conditions in the freshwater run-off to those of the open sea. Low temperatures in winter result in ice development and some damage to the saltmarsh results from moving ice following the breakup. High turbidity and high nutrient levels are typical.

Ecosystem

The ecosystem has been well studied, although models from saltmarshes in other countries do not always fully apply to Nova Scotia. They are normally highly productive as the plant life has access to abundant nutrients. Primary production is less in the Bay of Fundy region than in other areas. Some of the production is consumed within the saltmarsh habitat but a significant amount may be exported to other intertidal habitats on to the open water.

Successional Sequence

Plants (See pp. 337-338)
The plant life is composed almost entirely of salt tolerant (halophytic) angiosperms and algae, although microscopic fungi are important as decomposers. The angiosperms have to be especially well adapted to intertidal life and show such features as salt excretion (eg. Cord Grass) and water retaining (succulent) vegetative structure (eg. Glasswort). Many of the plant species are unique to the saltmarsh habitat. The saltmarsh is characteristically divided into High marsh and Low marsh each with a distinct plant community (Figure 84C).

Low marsh: The growth of Cord Grass (*Spartina alterniflora*) that begins the succession of saltmarsh development starts a little below mean high mark and extends up to the high tide mark. Cord Grass is the dominant plant, but algae, including the distinct, stunted form of rockweed, *Ascophyllum nodosum* var. *scorpoides*, also occur. On drier, bare patches Glasswort, Seablite, Seaside Sand Spurrey and Orach may be found.

High marsh: Dominated by Marsh Hay (*Spartina patens*), but also including a variety of other halophytes such as Sea Lavender, Arrow Grass, Seaside Plantain, Milkwort and various other grasses, sedges and rushes. On the Atlantic coast, the sedge *Carex paleacea* is commonly the dominant species. On the Bay of Fundy the high marsh is only inundated a few times each year during very high tides.

Pannes: The small ponds or pannes that develop during the course of succession (see Special features below) are colonized by Sea Lettuce (*Ulva* sp.), filamentous algae and aquatic angiosperms; Eel Grass in the low marsh and Ditch Grass and Horned Pondweed in the high marsh. These plants are particularly tolerant of a wide range of temperature and salinity. Eel Grass does not occur in the Bay of Fundy area. At higher levels the saltmarsh community grades in to vegetation typical of coastal freshmarsh and bog habitats.

Fauna

The resident animal life is specialized and largely composed of invertebrates. The invertebrates include both terrestrial species, largely insects and arachnids that invade the stands of *Spartina* during the growing season, and a variety of aquatic species. The aquatic invertebrates are marine species that can tolerate the temperature and salinity extremes and the large amount of suspended particulate matter. Detritus feeding amphipods (*Gammarus*) and isopods (*Idotea*), bivalve molluscs; Soft-shell Clam (*Mya*), *Macoma*, *Gemma*, *Geukensia* and *Mytilus* and gastropod molluscs; *Littorina*, *Hydrobia*, *Ilyanassa* and *Melampus* are all typical. The Ribbed Mussel (*Geukensia demissa*) and Bidentate Earshell (*Melampus bidentatus*) are characteristic molluscs of the Cord Grass (low marsh) and examples of localized warm water fauna.

The exceptional conditions of the pannes provide a habitat for tolerant species. Spire snails (*Hydrobia totteni*) and Periwinkles (*Littorina*) may be abundant. In Bay of Fundy marshes large populations of the coelenterate *Nematostella* have been recorded.

Killifish (*Fundulus* sp.), sticklebacks and Eels are often common in pannes and birds and mammals, particularly the raccoon, enter the habitat at low tide in search of food. The Sharp-tailed Sparrow breeds in this habitat.

Special Features

1. Pannes: Shallow ponds which develop initially in the low marsh because of poor drainage and uneven distribution of sediment. These ponds remain through the successional stages and are found in the high marsh. Pannes may be formed directly in the high marsh by destruction of areas of marsh sod by ice action. The extreme conditions in the pannes prevent colonization by the surrounding grasses.

2. Rising Sea Level: The character of saltmarshes in Nova Scotia is linked to rising sea level. Around the edges of marshes, dead Spruce trees demonstrate the slow (about one foot, 0.3 m/100 years) marine transgression. Several studies of Atlantic and Fundy saltmarshes have provided details of this phenomenon.

3. Halophytic (Salt tolerant) Plants: The characteristic flora of the marsh being largely composed of Angiosperms (flowering plants) with abilities to store water and excrete salt.

4. Cultural Associations: Associations between man and saltmarshes are of interest. Sweet Grass which occurs at the upper edge of many salt marshes is used in Micmac decorative work. Edible plants (Glasswort, Orach), the exploitation of Saltmarsh Hay (Spartina patens) and creation of dykelands through enclosure and drainage are also noteworthy.

5. Ecological Significance: The discussion regarding the natural benefits of salt marshes compared with dykeland, infilling or draining for other purposes, continues to be of importance.

Distribution in Nova Scotia

Saltmarshes are found in sheltered locations all around the coast of Nova Scotia. The high and low marshes of the upper region of the Bay of Fundy; Minas Basin (unit 601) and Chignecto Bay (unit 533), are the most extensive, although large areas have been converted to dykeland. Marshes along the Northumberland Strait and Atlantic coast are often well developed (eg. Chezzetcook Inlet and Chebogue, Yarmouth Co., district 830), but include also many small areas in bays and estuaries. These marshes are more productive than those of the Bay of Fundy. Although marginal salt marsh vegetation occurs in the Bras d'Or Lake there is no extensive development due to the negligible tide range.

ASSOCIATED TOPICS

T15 to T17 Colonization, T24 to T27 The Coastline, T36 to T47 Plants, T51 Wetland Birds and Waterfowl, T52 Shorebirds and T63 Marine Invertebrates.

ASSOCIATED HABITATS

H1 to H6 All Marine Habitats, H8 Coastal Freshmarsh, H9 Dune System, H32 Coastal White Spruce-fir Forest.

REFERENCES

Bromley and Bleakney (1979)
Erskine (1958)
Patriquin (1981)
Smith (1966)

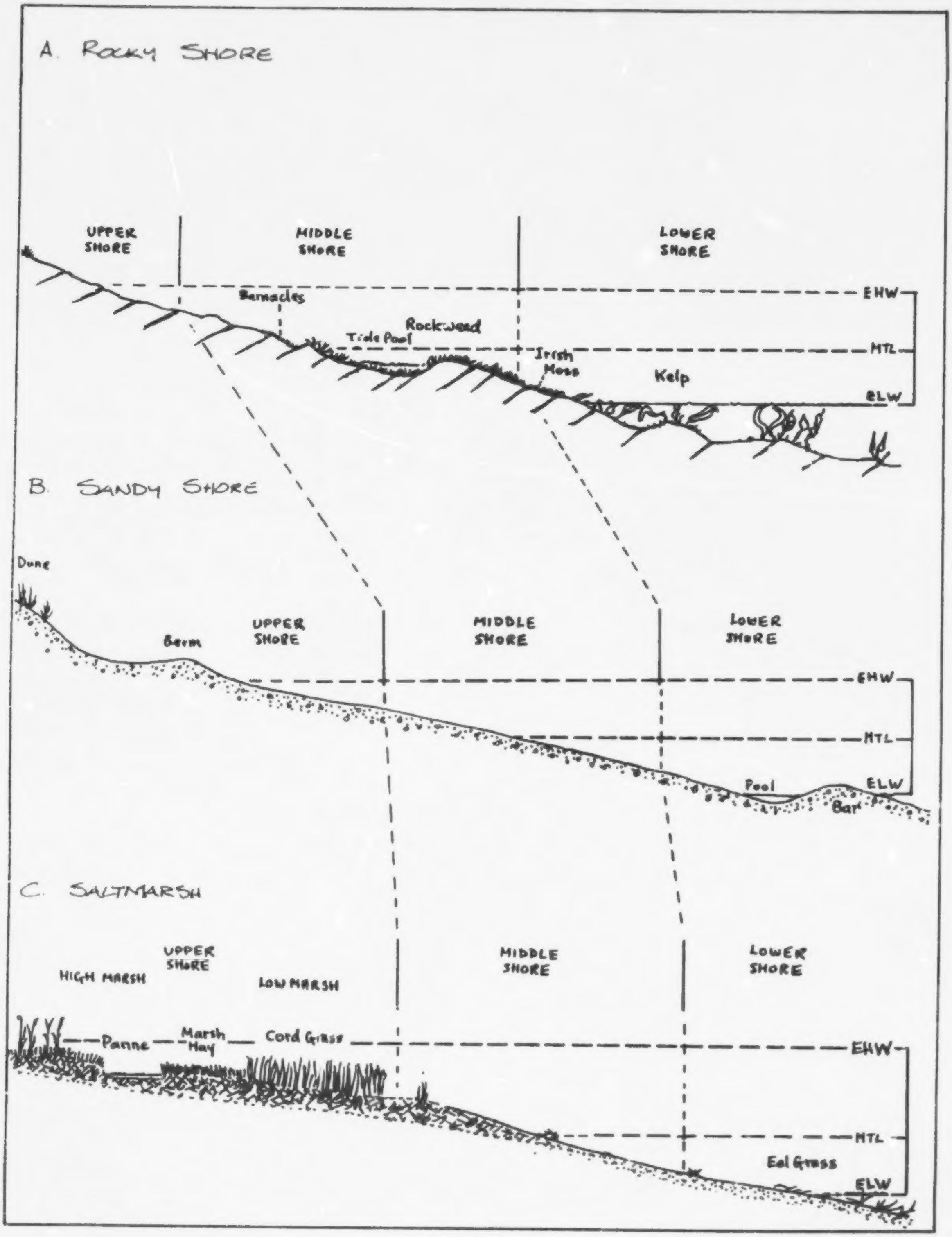
A. ROCKY SHORE
UPPER SHORE
MIDDLE SHORE
LOWER SHORE
Barnacles
Rockweed
Tide Pool
Irish Moss
Kelp
EHW
MTL
ELW
B. SANDY SHORE
Dune
Berm
UPPER SHORE
MIDDLE SHORE
LOWER SHORE
EHW
MTL
Pool
ELW
Bar
C. SALTMARSH
HIGH MARSH
UPPER SHORE
LOW MARSH
MIDDLE SHORE
LOWER SHORE
Panne
Marsh Hay
Cord Grass
EHW
MTL
Eel Grass
ELW

Fig. 84. A comparison of intertidal zonation on three types of shore on the Atlantic coast of Nova Scotia. Horizontal distances are not to scale. EHW = Extreme high water mark, MTL = Midtide level, ELW = Extreme low water mark.

H8 Coastal Freshmarsh

Freshwater wetland near the sea mainly colonized by non-salt tolerant plants.

Formation

The effect of seawater on the low lying coast is often moderated by freshwater run-off. Where this occurs the salt tolerant plants of the intertidal zone give way to non-tolerant species even though there may be a semidiurnal tide (upper reaches of estuaries) or occasional tidal flooding (low lying areas behind salt marshes).

Physical Aspects

Bedrock: Minimal outcropping, soft sedimentary rocks in the watershed contribute to soil development.

Soils: Alluvium, fine material rich in organic material and nutrients.

Relief: Low, generally flat, gently sloping to water.

Drainage: Poor, wet site with standing water in depressions. The marsh may be inundated by surface freshwater backed up by diurnal tides, especially during peak run-off and during highest spring tides.

Ecosystem

This is a highly productive system as there are abundant nutrients. The primary production is largely carried out by grasses, sedges and rushes. This production is either consumed or accumulates on site, adding organic material to the soil. In estuaries some of the production will be exported to lower reaches or to the sea. Consumers on site include water fowl and small mammals.

Successional Sequence

Intermediate between saltmarsh and freshwater fen. With rising sea level freshwater marsh will become more saline and will eventually become colonized by halophytes. Along river banks the marginal estuarine species will give way to freshwater species up-stream. The drier edges will be colonized by alder or willow.

Plants

The plant life present will vary according to local conditions but is dominated by conspicuous grasses, rushes and sedges.

1. At the upper edges of salt marshes where the freshwater from the water table is near the surface; bulrushes, cattails and sedges occur. Spartina pectinata is a common species. Reed Grass, Phragmites australis is common in some places in the Annapolis Basin, Minas Basin (unit 601) and Chignecto Bay (unit 533).
2. In sandy soil the nutrient condition may be relatively poor resulting in patches of vegetation similar to that of bogs. Sphagnum, rushes and cranberry, together with Sundew, Pitcher Plant, Seaside Buttercup, Marsh Cinquefoil and Silverweed commonly occur. This community is mainly found where sand dunes intergrade with salt marshes.
3. Bulrush marsh, may be extensively developed around shallow lakes, which also have abundant growths of pondweed (Potamogeton) and Ditch Grass depending upon the salinity.

Fauna

The aquatic fauna is generally poor, being restricted to insects and their larvae; waterboatmen (Corixidae), flies and mosquitos and succineid snails. Freshwater molluscs and other invertebrates may be introduced by migratory ducks and geese to more stable bodies of water. The bird and mammal life is important; particularly waterfowl, muskrat, raccoon, mink and small mammals. The Marsh Harrier nests on the ground in this habitat.

Special Features

1. Migratory waterfowl feeding areas: especially important in the fall and early winter. Also breeding for some species of duck.
2. "Elephant Grass" (Common Reed). The small beds of Phragmites australis that occur around the Annapolis area, Minas Basin and Tantramar Marsh are notable because of the

7-10 foot (2 to 3 metre) height of the full grown plant. The species occurs in many old dyked areas and may have been introduced by the French as a thatching material.

Distribution in Nova Scotia	This habitat is widely distributed in small areas all around the province, especially in association with salt marshes. The best development occurs in the upper reaches of the Bay of Fundy, in Cobequid Bay (unit 602) and Chignecto Bay (unit 533).

ASSOCIATED TOPICS

T24 to T27 Coastline, T36 Algae, T41 Seed-bearing Plants and T63 Marine Invertebrates.

ASSOCIATED HABITATS

H7 Saltmarsh, H9 Dune System and H15 Fen.

REFERENCES

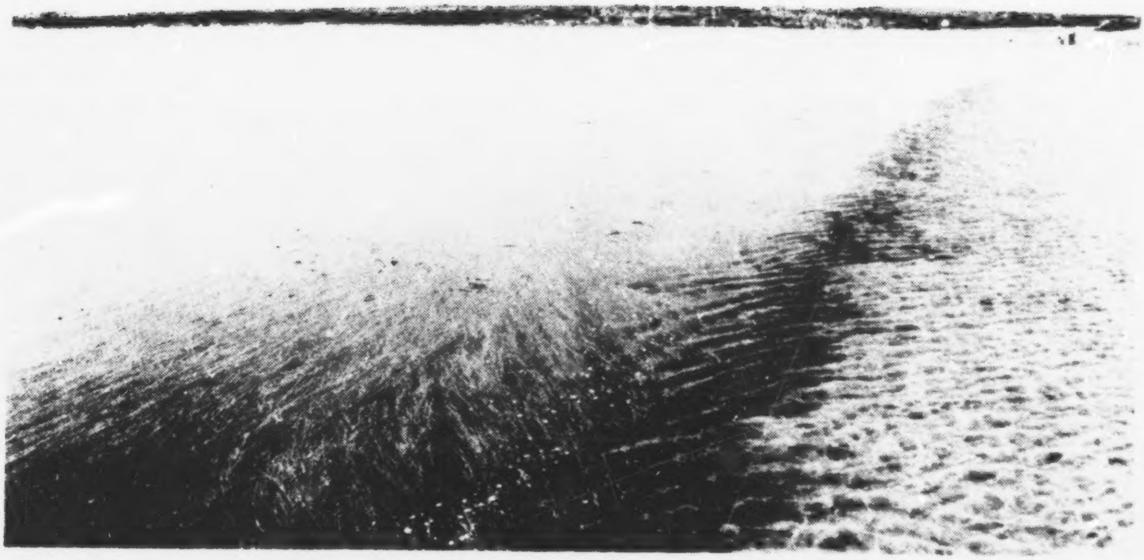

Fig. 85. An extensive Eel Grass bed in Lingan Basin, Cape Breton Co. This is a benthic habitat (H1) with sandy or mud bottom, commonly associated with mud flat (H6) and the lower levels of Saltmarsh (H7). Photo: R. Merrick

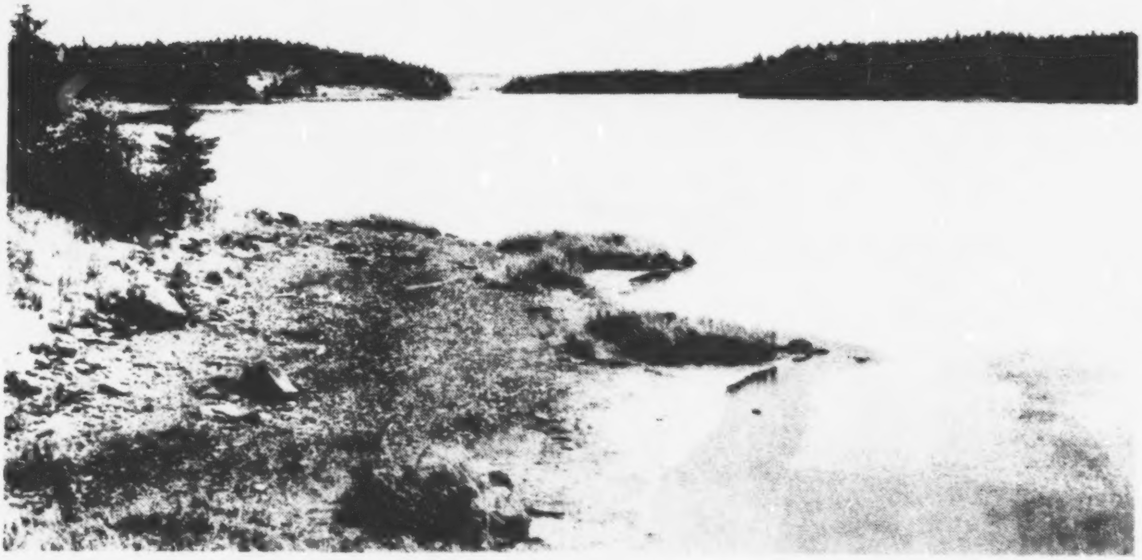

Fig. 86. The tidal estuary of the St. Mary's River, Guysborough Co., showing several patches of coastal freshmarsh (H8) on a muddy/gravel shore. Although tidal the surface water is almost always fresh. Photo: R. Merrick

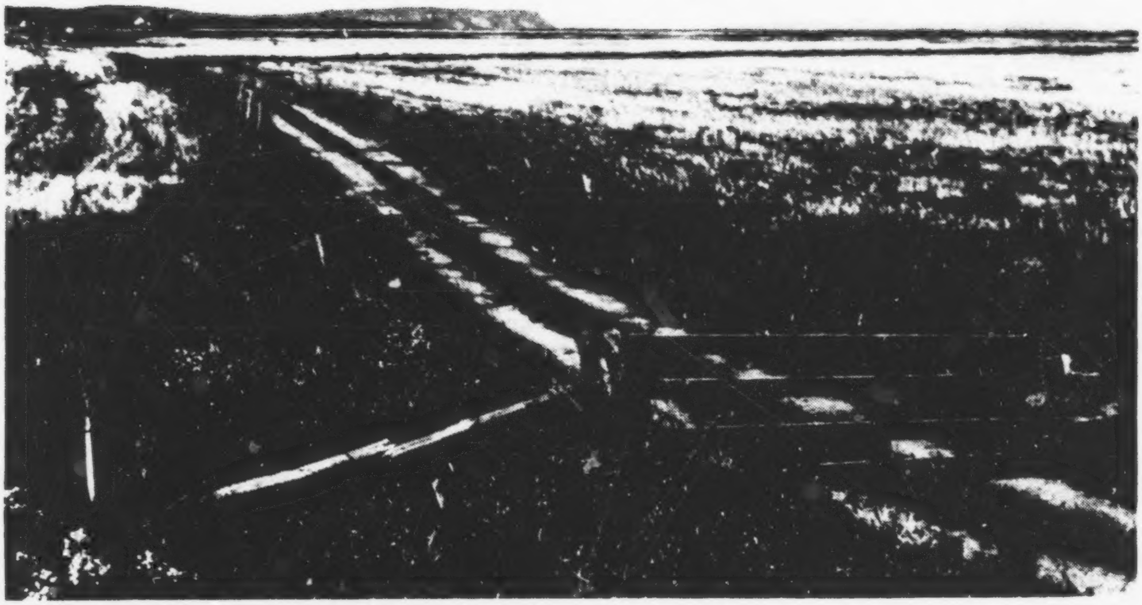

Fig. 87. Man-made habitat (H35). Dykeland near Grand Pré, Kings County, formed by the dyking and draining of salt marsh (H7).

Photo: T. Randall

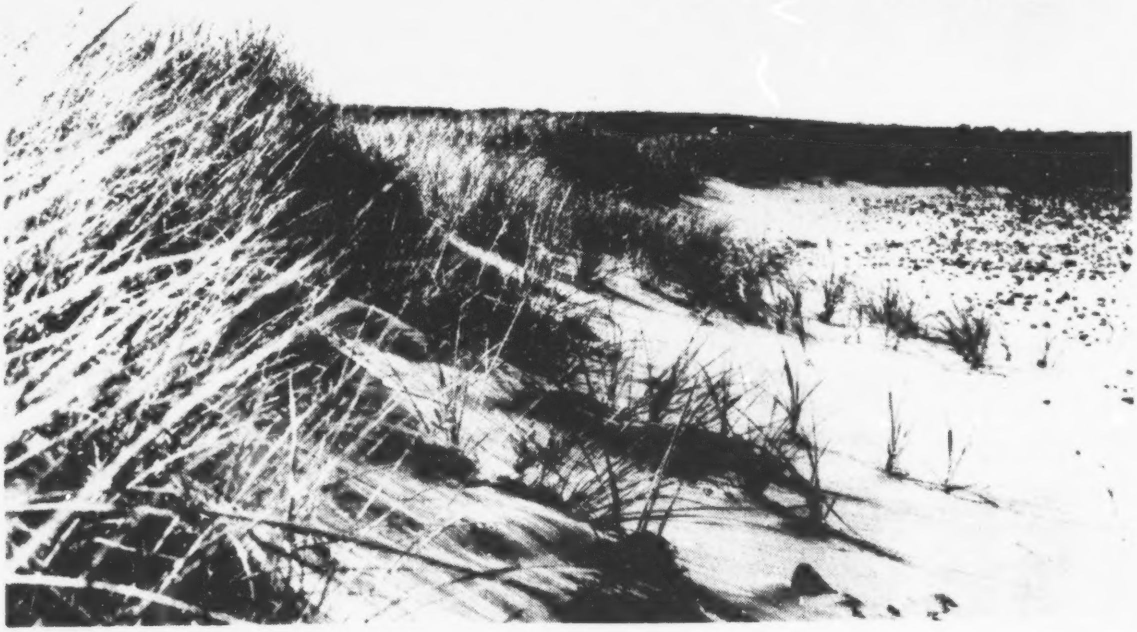

Fig. 88. Dune habitat (H9) at Dominion, Cape Breton Co. showing the dominant American Beach Grass.

Photo: R. Merrick

H9 Dune System

An exposed shoreline system of one or more sand ridges derived from wind and wave transported material.

Formation

In Nova Scotia this is a coastal habitat resulting from the deposition of sand on beaches in areas with sufficient sediment supply. Sand is deposited on the upper levels of the beach by both wave and wind action and becomes stablized by the growth of American Beach Grass (*Ammophila breviligulata*). New dune ridges are developed successively on the seaward side. The extent to which a coastal dune system will develop in Nova Scotia depends upon the sediment supply and the erosional/depositional environment, particularly the rate of sea level rise.

Physical Aspects

a) *Soil*: Wave and wind deposited sand, with low nutrient level.
b) *Relief*: A succession of parallel ridges (dunes) and depressions (slacks). Ridges become lower and wider with age due to compaction and spreading.
c) *Drainage*: Good on the ridges but the leaching of material from the sand results in the eventual formation of hard pans and interrupted drainage in the slacks.
d) *Exposure*: High degree of exposure resulting from wind, blowing sand and salt spray.

Ecosystem

This is a natural ecosystem with low species diversity in the early stages of succession. Primary production is low due to low nutrient levels and exposure. Diversity of consumers increases during the course of succession. The initial grassland system changes to a forest system over time.

Successional Sequence

On a prograding dune system, bare, loose sand of the beach is colonized and stablized by American Beach Grass. As the stable soil increases organic (humus) content and water-retaining capability the Beach Grass community is replaced by an increasing variety of plant species including heath plants, before giving way to coastal spruce, fir forest. The seral stages are usually represented by dune ridges of different ages, with distinct plant communities (see below). The details and extent of the successional sequence will depend upon local conditions. The destruction of the vegetation cover in the dune system can cause damage to the system by wind erosion (blow-outs). Sand dunes often provide the shelter required for salt marsh development.

Plants

There are distinct plant communities associated with the seral stages of dune succession. These are summarized on the diagram of the Pomquet dune system shown in Figure 89.

The most important species that dominates the pioneer plant association is American Beach Grass. Colonization of new sand may be by seed or runners from the established plants on the primary ('yellow') dune ridge. The pioneer plant association includes typical beach plants; Sea Rocket, Sandwort and Orach.

The 'yellow dune' is again dominated by American Beach Grass but the diversity of plant species is increased to include Poison Ivy, and the sedge, *Carex silicea*. Beach Pea is another species of this community.

The 'Grey dune' community in which active deposition of sand has ceased continues the basic association of 'yellow dune' but the Beach Grass is beginning to give way to a variety of other plants including other grasses, Scouring Rush, Bayberry and lichens. Lichens, particularly species of *Cladonia*, may be the dominant vegetation in fairly extensive patches.

The 'Grass-land' community shows the final replacement of the Beach Grass by other grass species and the last stage before the 'Heath and Scrub' ecotone that borders the White Spruce/fir forest habitat development (see H32). This community commonly includes Wild Rose and various heath plants as well as individuals of the pioneer conifers.

In the depressions between beach ridges known as "slacks", poor drainage and low nutrients support a plant association of a 'bog' character with Sweet Gale and Cranberry. In later stages of succession these may become alder swamp or pond habitat.

Animals

The development of fauna depends upon the stage of succession. Improved stable soil and plant species diversity support more diversified fauna. The upper sand beach community of amphipods (Talorchestia), tiger beetles; flies and spiders (see Sandy Shore H5) extends into the colonizing zone of the Beach Grass. At later seral stages the diversity of insects increases and other groups of soil organisms such as snails and slugs become established. Vertebrates include snakes, small mammals and birds; Savannah Sparrow (Ipswich Sparrow on Sable Island) and Snow-buntings in winter.

Special Features

1. Pioneering role and adaptation of American Beach Grass.
2. Classic features of sand dune succession
3. Fragility of the system
4. Special case of Sable Island - Ipswich sparrow.

Distribution in Nova Scotia

Sand dune systems occur in exposed coastal areas where there is adequate sediment supply. Northumberland Strait (district 530), Cape Breton (districts 540 and 550), and the Atlantic coast (districts 830 and 840) have the best examples. Pomquet Beach, Antigonish Co. is the best provincial example of a prograding dune system. Management of sand dunes is an essential part of recreation beach development. There are only a few sand dunes in the Bay of Fundy, for example Apple River.

ASSOCIATED TOPICS

T24 to T27 The Coastline; T38 Lichens, T41 Seed-bearing Plants and T45 Successional Trends in Vegetation.

ASSOCIATED HABITATS

H5 Sandy Shore, H7 Saltmarsh, H32 Coastal White spruce, fir forest.

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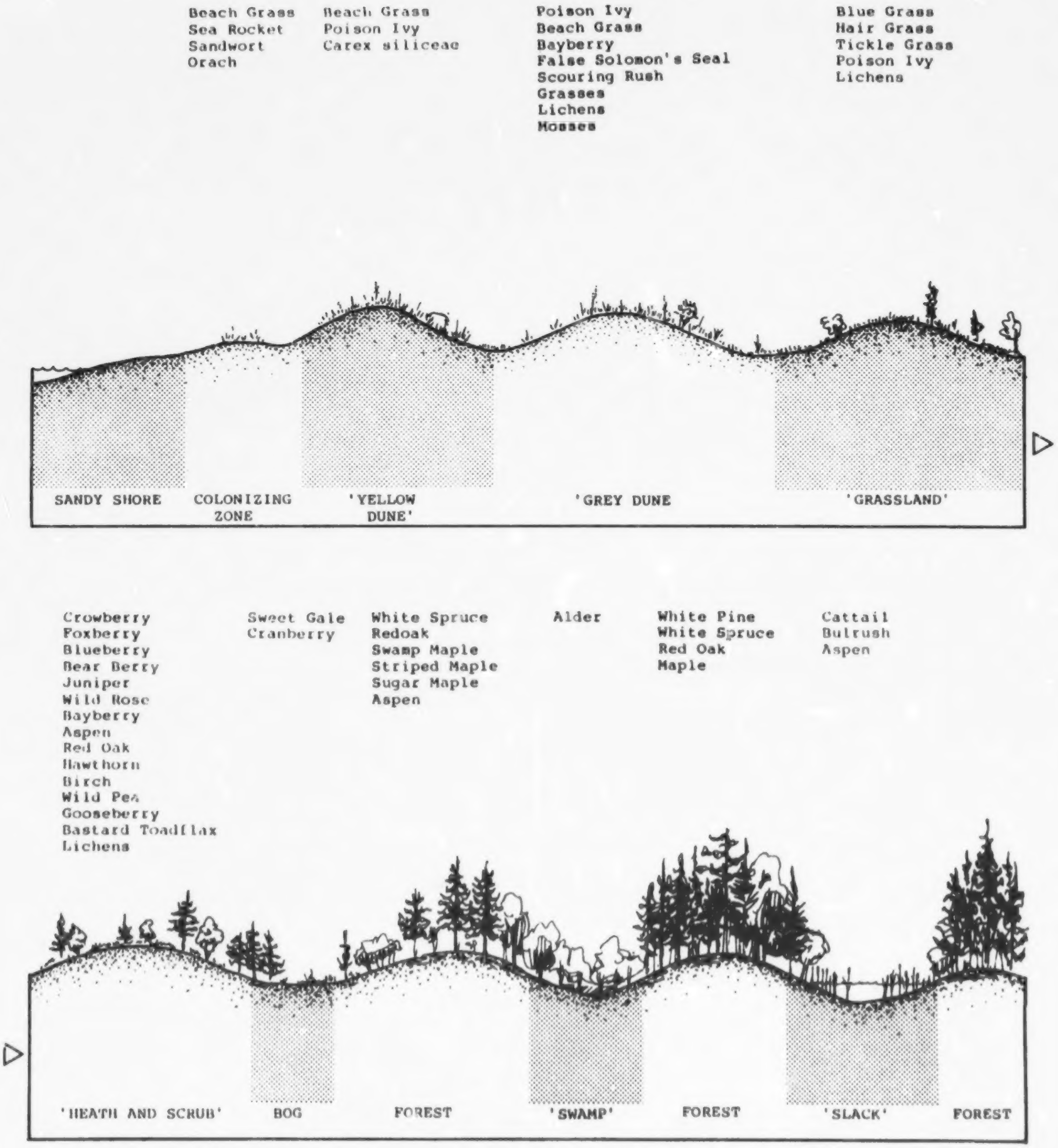

Beach Grass
Sea Rocket
Sandwort
Orach
Beach Grass
Poison Ivy
Carex siliceae
Poison Ivy
Beach Grass
Bayberry
False Solomon's Seal
Scouring Rush
Grasses
Lichens
Mosses
Blue Grass
Hair Grass
Tickle Grass
Poison Ivy
Lichens
SANDY SHORE
COLONIZING ZONE
'YELLOW DUNE'
'GREY DUNE
'GRASSLAND'
Crowberry
Foxberry
Blueberry
Bear Berry
Juniper
Wild Rose
Bayberry
Aspen
Red Oak
Hawthorn
Birch
Wild Pea
Gooseberry
Bastard Toadflax
Lichens
Sweet Gale
Cranberry
White Spruce
Redoak
Swamp Maple
Striped Maple
Sugar Maple
Aspen
Alder
White Pine
White Spruce
Red Oak
Maple
Cattail
Bulrush
Aspen
'HEATH AND SCRUB'
BOG
FOREST
'SWAMP'
FOREST
'SLACK'
FOREST

Fig. 89. A diagramatic cross-section of a prograding dune system showing the main features of succession. Based upon information from Pomquet Island, Antigonish Co. Not drawn to scale.

FRESHWATER

H10 Freshwater Pond

A small, shallow body of freshwater formed in depressions or by interruption of natural drainage.

Formation

Ponds may be formed in the following ways:

1. Scouring action of glacial ice, or damming by deposition of glacial till.
2. By infilling of a lake with organic debris (bog) or mineral sediment.
3. By natural cut off of a meander on a river (ox-bow pond).
4. By solution of gypsum or limestone (sink-hole ponds).
5. Natural daming by landslides, flood debris or beaver activity.
6. Damming or excavation by man.

Physical Aspects

a) Bedrock: may occur in all bedrock types as well as in alluvial or glacial deposits.
b) Soils: lake-bottom muck
c) Relief: depressional topography
d) Drainage: very poorly drained; partially open water

Ecosystem

As the pond is found in a depression it usually receives mineral and organic material through drainage. Primary production is usually high except in dystrophic conditions. Nutrient enrichment will commonly develop a eutrophic condition because of low flushing rates. The aquatic plants responsible for primary production support diverse and often large populations of consumer organisms. However a large part of the organic material produced remains on site and contributes to the silting up of the pond.

Successional Sequence

The shallow edges of a pond support often rich aquatic vegetation. The organic material produced by these plants and silt brought in by surface run-off contribute to the silting up of the pond and its eventual conversion to a terrestrial habitat. In the early stages of succession there is a large area of open water with distinct zones of plants around the margins, related to the depth of water. (see below and Figures 92 and 93). As the pond silts up these zones progress towards the middle, closing the open water area and giving rise to bog, fen, swamp or marsh habitats. The pace at which this proceeds depends upon the rates of introduction of silt, rate of production of organic production and rate of decomposition.

Plants

The plants around a pond margin are classified into four main zones.

1. Zone of vegetation characterized by the sedge *Dulichium arundinaceum*, Sphagnum Moss, with terrestrial fen or swamp plants.
2. The zone of *emergent* plants. These are rooted in the pond bottom but are largely emergent. The zone is characterized by Pickerel weed (*Pontedaria*) association which includes Spike Rush, Bog Buckbean, Pipewort, Arrowhead, Cattail and Bulrush, depending upon the pH of the water and geographic location.
3. The zone of *floating* plants mainly characterized by the Waterlily and Pondlily association, but including Pondweeds (*Potamogeton*). In small ponds with little surface movement duckweeds (*Lemna*) are usually found covering the surface.
4. The zone of submerged plants is the outer zone of plants in the pond. The character of this zone varies with the region as the plants generally require an oligotrophic water condition rather than the dystrophic condition of acid rock areas. This zone includes species of Pondweed, Millfoil, White Watercrowfoot, Canadian Pondweed (*Elodea*) (Truro area) and the calcareous algae, Stonewort (*Chara*), in gypsum or limestone bedrock areas.

The open water includes a planktonic plant community of diatoms and desmids which is hard to separate from the aquatic plant zones in small ponds.

Animals

The plant growth at the edges of ponds provides food for a wide variety of invertebrate animals, the most important of which are insects. Adults of beetles and bugs are common and are mostly predatory, feeding upon the larvae and nymphs of mosquitos, mayflies, caddisflies, dragonflies, etc. There are also both planktonic and benthic species of crustacea; ostracods, cladocerans, copepods, one ubiquitous species of amphipod (Hyalella azteca) and one Isopod (Asellus sp.) in southwestern Nova Scotia. Other invertebrates include species of oligochaete worms, leeches and gastropod (snails) and bivalve (clams) molluscs. In very small, isolated ponds the diversity of species other than flying insects will be limited as some form of introduction via a carrier is needed. The Pea clams, for example, may be introduced by birds, insects or amphibians. In very small temporary (vernal) ponds the animals have to be able to stand long dry periods in estivation or hibernation.

The vertebrate fauna will vary according to degree of isolation from larger water systems and geographic region. In isolated ponds fish may be excluded from the fauna which is an advantage for the larvae of salamanders and tadpoles of frogs which use the ponds for their early development. Turtles are also mobile and colonize larger ponds. The birds include the Redwinged Blackbird that nests in cattails, and Blackduck in ponds with a large open water area. Also seen are herons, bitterns, waterfowl, many small passerines, and aerial foragers such as Tree Swallows. Mammals include mink, beaver and otter.

Special Features

1. Because ponds are small and greatly affected by local climatic and geological conditions they are quite different in various regions of the province. To understand a pond in any detail it is important to understand its origin, eg. sinkhole, river ox-bow, beaverdam, etc.
2. Plant succession.
3. Amphibian populations.

Distribution in Nova Scotia

Ponds are found throughout Nova Scotia but are often of different origins in different regions.

ASSOCIATED TOPICS

T29 and 30 Surface Waters, T36 Algae, T45 Succession, T51 Wetland Birds, T54 Small Mammals, T58 Amphibians and Reptiles, T59 Invertebrates, T60 Freshwater Fishes.

ASSOCIATED HABITATS

H9 Dune System, H11 Freshwater Lake, H12 Slow-moving Stream, H14 Bogs, H15 Fen, H16 Swamp, H21 Cave.

REFERENCES

Gilhen (1972)
Daubenmire (1968)
Davis and Gilhen (1982)
Stanley et al (1973)
Wright (1972)

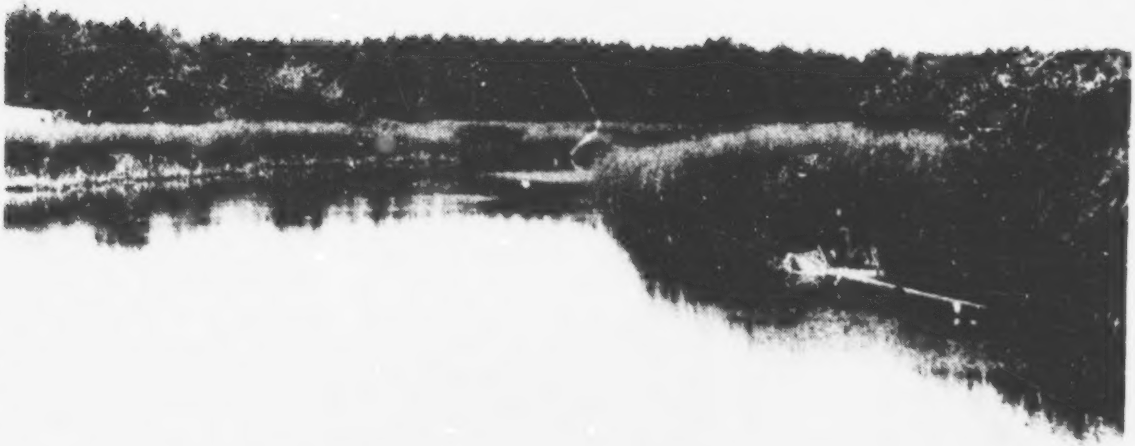


Fig. 90. A freshwater pond (H10) near the coast at Northport, Cumberland Co. It is Oligotrophic and has abundant aquatic plants (Potamogeton and Juncus). Photo: D.S. Davis

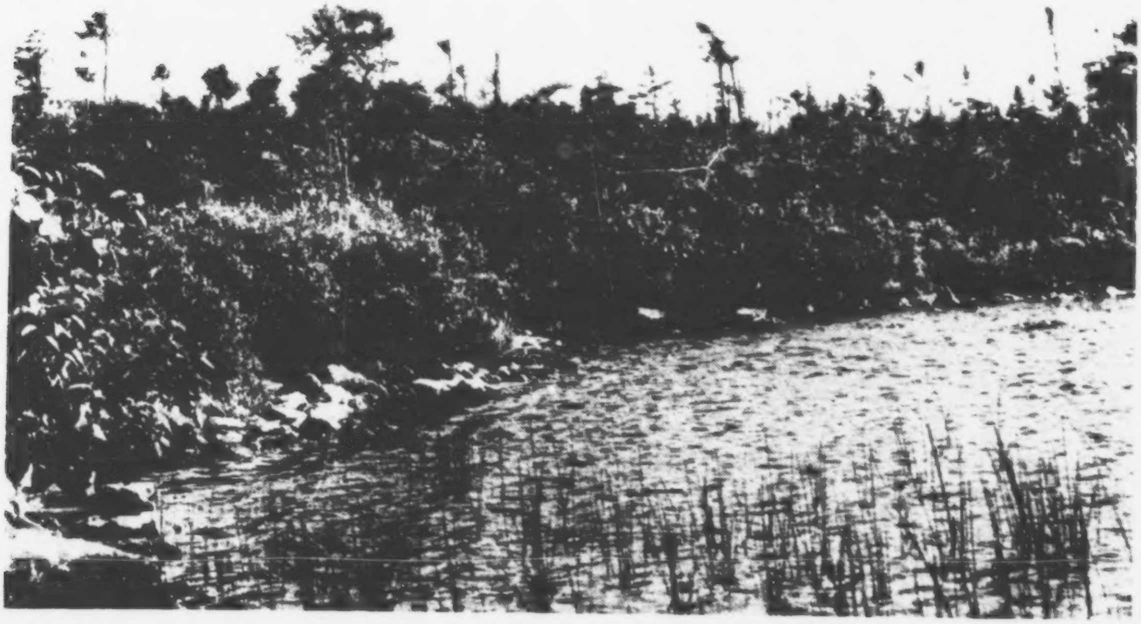


Fig. 91. A lake shore (H11) at French Lake, Inverness Co. The lake is dystrophic and has sparse vegetation (mainly Juncus). The scrubby forest is fir, black spruce, larch (H33). Photo: D.S. Davis

H11 Freshwater Lake

A body of open water having a wave-beaten marginal zone which is, for the most part, devoid of macroscopic vegetation other than that found in the littoral zone in sheltered coves and embayments.

Formation — A lake originates from a geological process, in the case of Nova Scotia, this process being mainly glaciation. Ice-scouring results in depressions in the bedrock or surface irregularities in glacial drift.

Physical Aspects

a) Bedrock: occurs on all bedrock types but predominately hard igneous and metamorphic rock (mainly in region 400).
b) Soils: lake-bottoms muck.
c) Relief: depressional topography
d) Drainage: open water

Ecosystem — A lake ecosystem is a body of open water having a wave-beaten marginal zone which, for the most part, is devoid of macroscopic vegetation within the habitat. Occasionally plant communities can be found within the sheltered areas of littoral zone along the shoreline. The level of primary production depends upon nutrient availability, lake morphometry and flushing rate. Consumer organisms are found in planktonic, benthic and littoral communities (Figure 79).

Successional Sequence — The outline of the shoreline tends to be quite irregular during its early life but waves and wind-induced currents begin to wear away headlands, depositing the eroded materials in sheltered areas to eventually produce a smooth shoreline. A vertical erosional-depositional process also takes place within the lake. Infilling of the lake basin results from suspended sediment being brought into the system by inflowing rivers. This sediment is deposited in the deeper parts of the lake until the bottom is slowly built up to a planed surface. A lake is said to be approaching senility when the water level becomes so shallow that wave action decreases and erosion consequently declines to a very slow rate. This allows the establishment of an abundance of plant species, both in numbers and species diversity. At about this point the lake takes on the characteristic of a pond.

Plants

Macroscopic plant communities are found in the littoral zone (the depth to which light of a certain intensity can penetrate to the bottom). Three prominent plant communities found are: the *Nymphaea*-*Nuphar* and *Pontederia* plant associations occurring in standing water and the *Lobelia*-*Lysimachia* plant association occurring in frequently inundated areas.

The *Nymphaea*-*Nuphar* (Waterlily-Pondlily) association is typically found in lakes, ponds, and slow-moving streams and rooted to a mucky bottom. Characteristic plant species include the floating leaved plants Waterlily and Pondlily; a unique submergent species, Bladderwort, and Pondweed, generally found resting on or near the bottom.

The *Pontederia* (Pickerelweed) plant association is also typical of lakes, ponds, and slow-moving streams. This association is best developed in mucky, sheltered areas. The tall emergent Pickerelweed is the dominant species with Spikerush and Sphagnum moss (*Sphagnum cuspidatum*) as subdominants.

The *Lobelia*-*Lysimachia* (Lobelia-Loosestrife) association is characteristic of frequently inundated areas of the lakeshore with a mineral substrate. This association remains dormant until late summer when the water level of the lake is at its lowest. Water Lobelia and Loosestrife are the dominant species. Subdominant or characteristic species include Twig Rush and Pipewort. Also found along the shoreline is the *Spartina* (Broad Leaf) plant association. This community is restricted to exposed, wind-swept, rocky beaches which may be inundated in the spring. Dominant species include Broad Leaf (*Spartina pectinata*) and Panic Grass. In southwestern Nova Scotia shorelines are habitat for some rare coastal plant species.

Animals

The large size of lakes provides for several distinct types of fauna associated with different habitat conditions. The sheltered shores where there is sediment deposition in the littoral zone provides a habitat similar to that of a pond and the types of animals present are largely the same. However, the diversity of fish species is greater and predation of invertebrates more significant than in ponds. Bullheads are typical of the littoral zone.

Exposed shores, subjected to wave action have rocky or cobbly shores largely unsuitable for rooted vegetation and the animals are correspondingly sparse. Insect larvae such as the caddisfly *Helicopsyche* and snails, *Physa*, *Lymnaea* and *Amnicola* are found attached to stones. This is generally an impoverished state of the sheltered shore fauna. Mussels such as *Elliptio* burrow in patches of gravel. Spotted sandpipers are commonly seen along the shore. Migratory waterfowl, loons, cormorants and gulls are also found in this habitat.

The benthic community of the profundal zone is adapted to the conditions of soft mud and low oxygen. Due to the development of a thermocline during the summer the bottom waters of productive lakes may become anaerobic. The bottom water of oligotrophic lakes however, usually have abundant oxygen and support mainly game fish rather than coarse fish. Characteristic animals are larval chironomidae (midges) which are eaten by fish.

The planktonic community of the open water (limnetic zone) includes Cladoceran and Copepod crustaceans feeding upon the diatoms and desmids. The plankton, together with insects that alight on the water surface, provide food for open water fish such as lake trout, brown trout and lake whitefish.

Special Features

1. Landlocked Salmon, Lamprey eels, Acadian Whitefish and lake populations of Brook Trout.
2. Coastal plain shoreline flora (southwestern Nova Scotia).

Distribution in Nova Scotia	Scattered throughout the province but abundant in the southern half of the province (the Atlantic Interior region 400).

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T29 and T30 Surface Waters, T43 Plant Communities and T45 Succession.

ASSOCIATED HABITATS

H10 Freshwater Pond, H12 Slow-moving Stream, H14 Bogs.

REFERENCES

Davis (1981)
Davis and Wilson (1979)
Daubenmire (1968)
Keddy (1979)
Macan and Worthington (1972)
Odum (1959)
Smith (1966)
Stanley et al (1973)

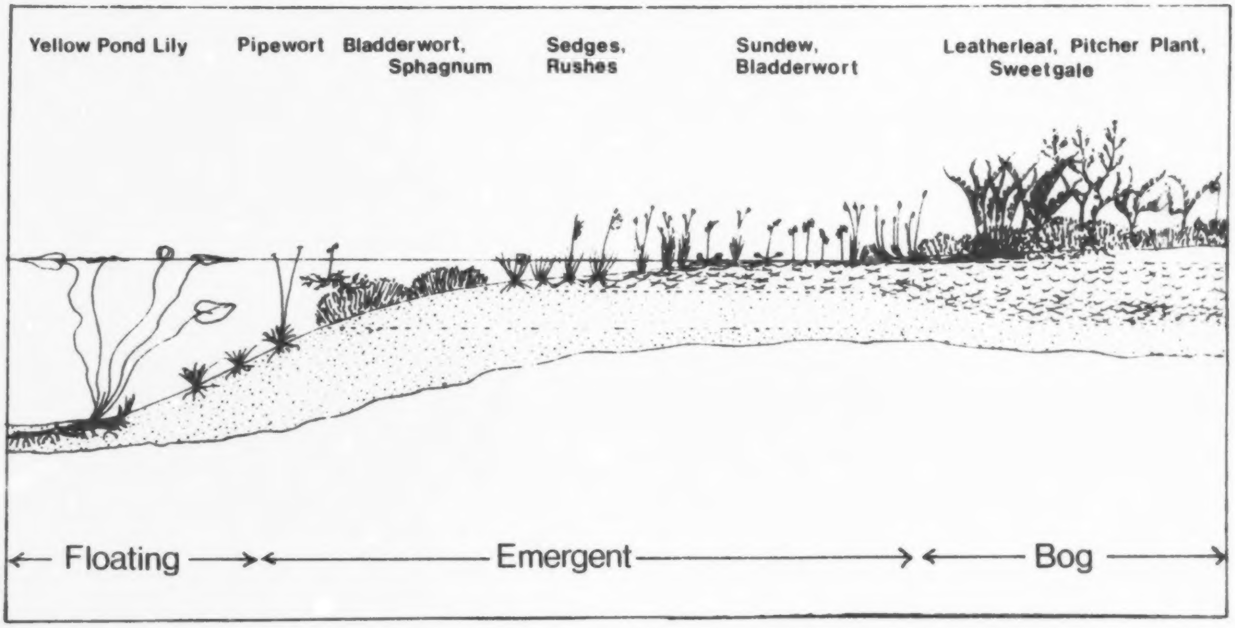

Yellow Pond Lily
Pipewort
Bladderwort, Sphagnum
Sedges, Rushes
Sundew, Bladderwort
Leatherleaf, Pitcher Plant, Sweetgale
Floating
Emergent
Bog

Fig. 92. Zonation of aquatic vegetation at the edge of dystrophic pond or lake in association with a bog.

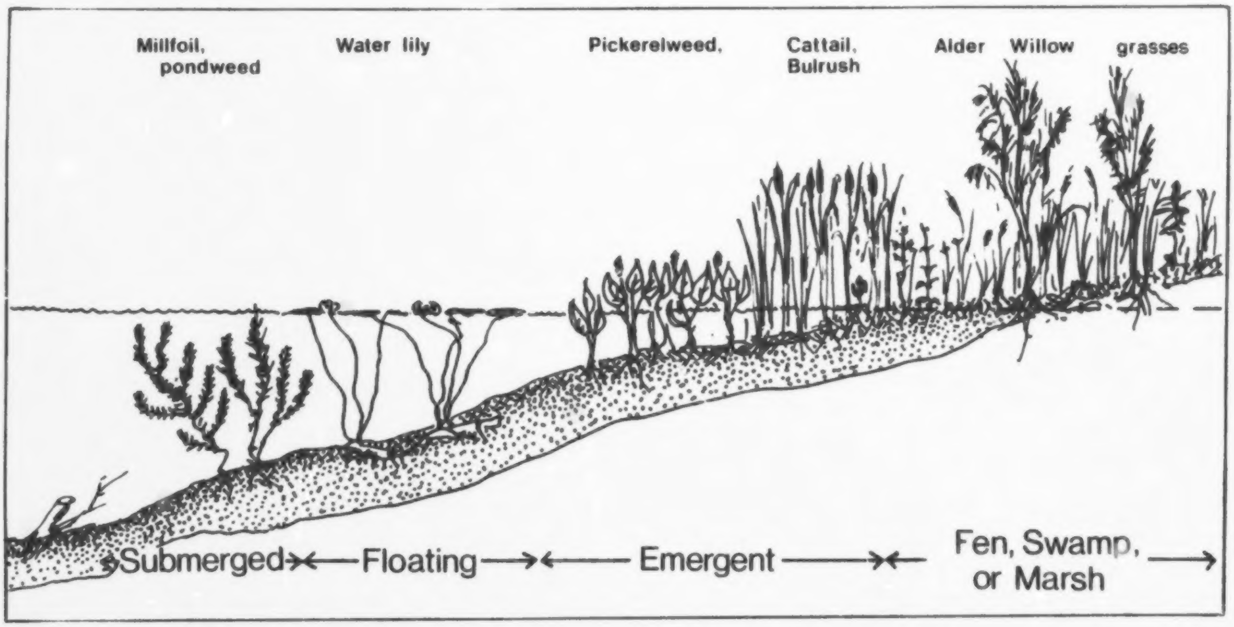

Millfoil, pondweed
Water lily
Pickerelweed,
Cattail, Bulrush
Alder
Willow
grasses
Submerged
Floating
Emergent
Fen, Swamp, or Marsh

Fig. 93. Zonation of aquatic vegetation at the edge of an oligotrophic pond or lake in association with a fen.

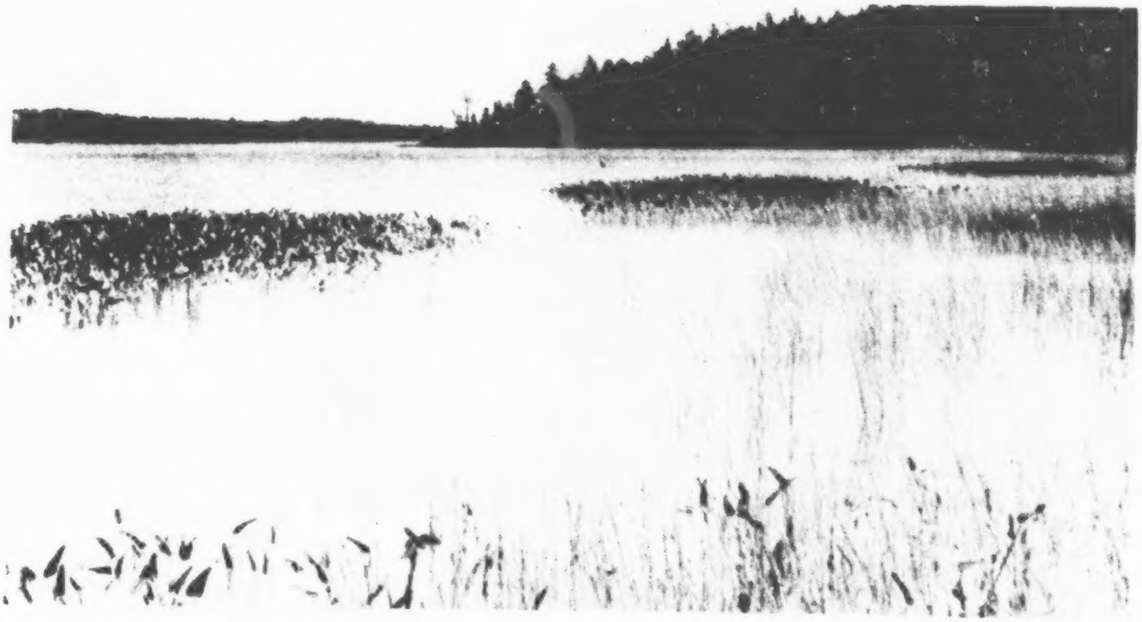


Fig. 94. A sheltered lake shore (H11), showing emergent vegetation of rushes and Pickerell Weed. Killarney Lake, Cumberland Co.
Photo: D.S. Davis

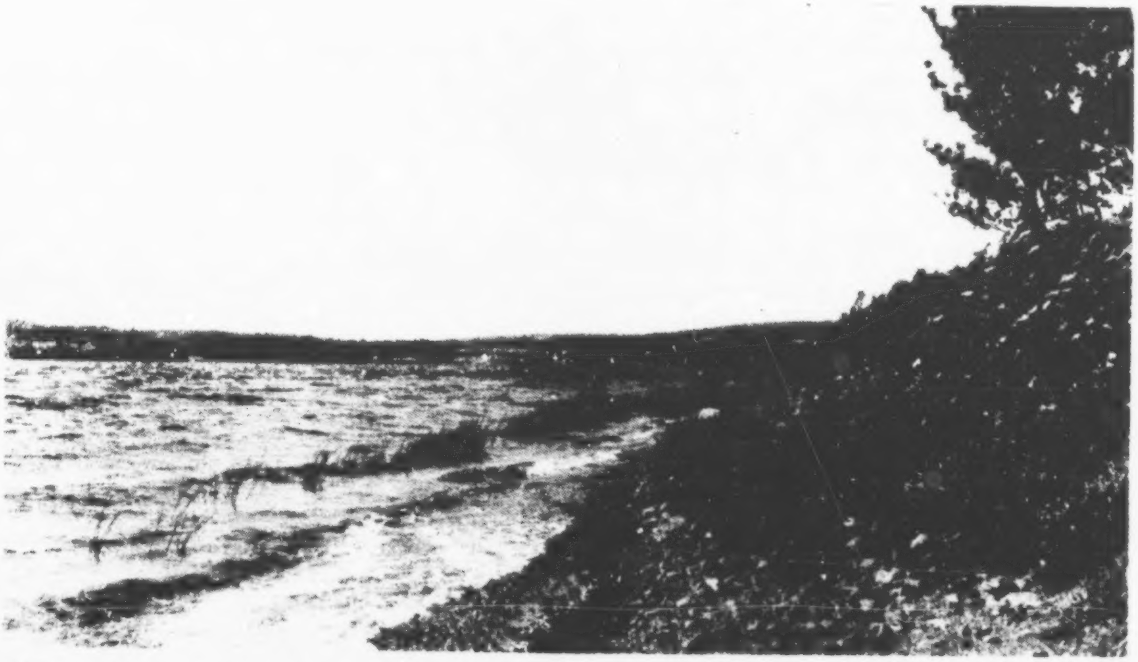


Fig. 95. An exposed lakeshore (H11) showing a wave-washed gravel shore and sparse vegetation of rushes. Eden Lake, Pictou Co.
Photo: R. Merrick

H12 Slow-moving Stream

A body of flowing freshwater where the velocity is low, providing both erosional and depositional environments.

Formation

The rapidly moving streams of upland areas slow down as they reach more level terrain, lakes, bogs or other wetland areas. The form of the river will reflect the character of the terrain and the nutrient level and sediment load of the particular streams. The character of slow moving streams thus differs considerably in different regions. Some rivers that become slow moving may be "rejuvenated" in rapids and falls due to geological features. The slow moving stream often has a flood plain, meanders and associated features, and terminates in a lake or tidal estuary.

Physical Aspects

a) Bedrock: Any bedrock, but mostly sedimentary rock and thick glacial till.
b) Soils: fluvial sediments, silt, mud, sand and gravel with varying amounts of organic material.
c) Relief: in depressions, gently undulating and sloping towards the coast.
d) Drainage: water body; slow current.

Ecosystem

The slow-moving stream generally provides a higher level of production than is found in rapidly moving streams. The bog and floodplain margins provide numerous shallow channels and backwaters that support plant growth. The level of primary productivity will vary according to nutrient levels and other factors. Some of the organic material will be exported, some will remain on site to develop peat and some will be consumed by herbivores. The diversity of consumer organisms varies with the physical condition and vegetation. This habitat is important for fish.

Successional Sequence

The development of the habitat depends upon the depositional and erosional characteristics of the river. There is a progressive down stream movement of meanders, leaving shallow, deep pools, backwaters, braided channels and ox-bow ponds. Sediment is deposited on the floodplain during flood periods, slowly filling up old erosional features. The vegetation and fauna of the river constantly adjust themselves to these changing conditions.

Plants

The variable physical condition of the habitat results in a diversity of plant communities along the stream bank. These include vegetation characteristic of bog (H14), fen (H15), pond (H10) swamp (H16) and floodplain forest (H34). The reader is referred to these particular habitat descriptions. The riverbed itself is colonized by often dense growths of Bur-reed (Sparganium), and pondweed (Potamogeton), mosses and algae. Rushes and sedges are important in stony shallows. In calcareous water the algae Chara may also be found. Vegetation is generally absent from deep pools that have maximum erosion.

Animals

As with plants the aquatic animals of the slow moving stream include the rich diversity described for bog, fen, pond and fast moving stream habitats. The invertebrates are dominated by nymphs and larvae of insects; blackfly, dragonfly, mayfly, stonefly caddisfly, waterbugs and waterbeetles. Leeches, oligochaete worms and molluscs are plentiful in oligotrophic waters. Freshwater mussels may be particularly abundant in some areas and include some species with limited distribution.

The invertebrates provide a good food resource for fish, both resident and anadromous species such as Atlantic Salmon and Gaspereaux which seasonally migrate through the system and spawn on gravel bottoms. Amphibians are common and may breed and develop in the shallow pond habitats of backwaters. Wood Turtles hibernate in the deeper pools of the river and lay their eggs on sand banks. Most bird species are mainly associated with the adjacent forested habitats. Exceptions are mergansers, Black Duck, Spotted Sandpiper, and Belted Kingfisher. A few mammals; Water Shrew, Star-nosed Mole, Muskrat, Otter, Mink and Beaver are characteristic of the river habitat.

Special Features

1. Special adaptations of stream organisms.
2. Hibernation and breeding of Wood Turtles.
3. Freshwater mussels; their association with fish through the parasitic (glochidia) larval stage and rare species, eg. *Lampsilis cariosa* in Sydney River.
4. Important commercial and sports fish, particularly salmon; spawning areas on gravel bottoms and history of the status of the species.
5. Dystrophic and Oligotrophic waters, acid rain.
6. Development of estuarine character near the coast.
7. Modification of river courses by activities of man.

Distribution in Nova Scotia

Found in all regions of Nova Scotia except where high ground is located close to the sea. Well developed in larger river systems; Tusket, Medway, Mersey, LaHave, St. Marys (region 400), Shubenacadie, Stewiacke and others in region 500, Cornwallis and Annapolis (region 600) but also present in many others.

ASSOCIATED TOPICS

T11 to T14 Landscape Development, T29 to T30 Surface Waters, T58 Amphibians and Reptiles, T59 Invertebrates and T60 Freshwater Fishes.

ASSOCIATED HABITATS

H10 Freshwater Pond, H11 Freshwater Lake, H13 Rapidly-moving Stream, H14 Bogs, H15 Fen, H16 Swamp, H34 Flood Plain Forest.

REFERENCES

Scott and Gilhen (1981)
Smith (1966)
Wright (1972)

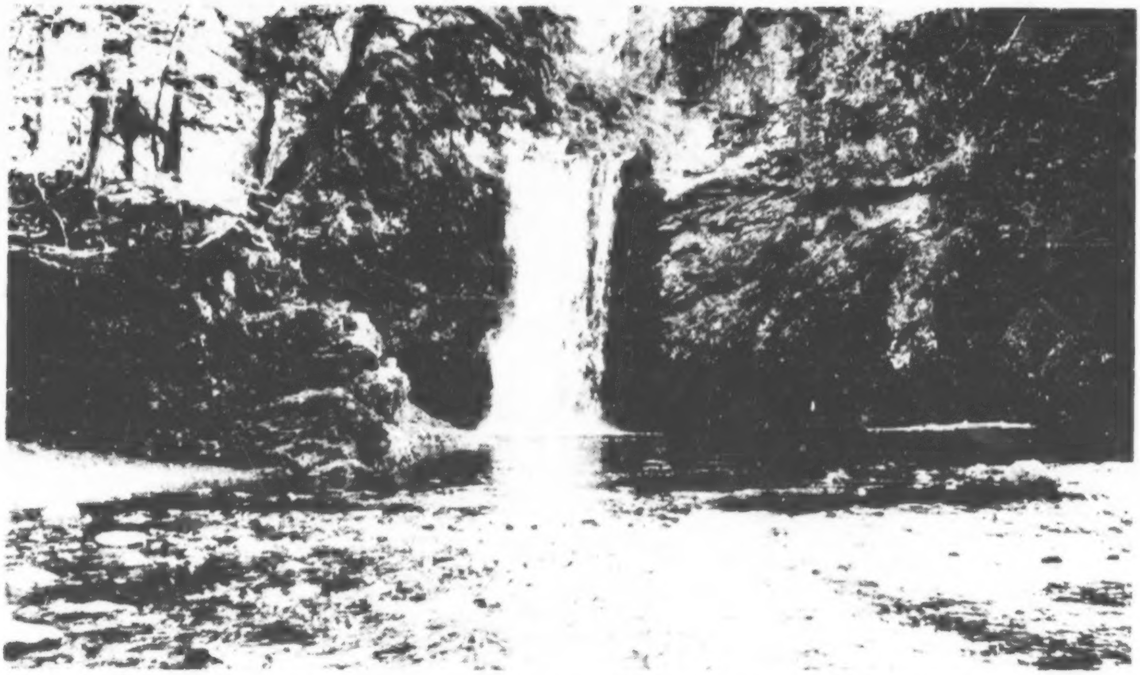


Fig. 96. A rapidly moving stream (H13) with a waterfall and associated cliff habitat (H19). The forest is spruce-hemlock, pine (H25). Drysdale Falls, Colchester Co. Photo: R. Merrick

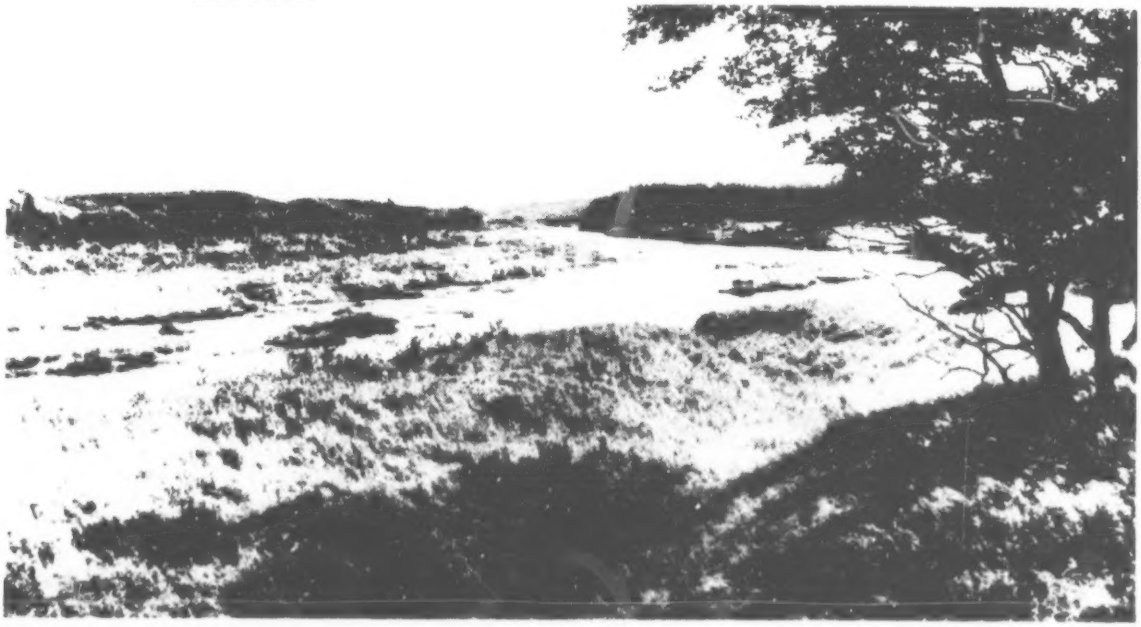


Fig. 97. A slow moving stream (H12) with marginal fen (H15) on the floodplain. St. Mary's River, Guysborough Co. Photo: R. Merrick

H13 Rapidly-moving Stream

A running freshwater system where velocity is sufficient to maintain an erosional environment.

Formation	Water running off of the land follows courses of least resistance and develops these as distinct channels by erosion. In the upper (young) courses of streams, erosion is more important than deposition where the water velocity is sufficiently high. Similar conditions prevail where a slow moving stream is rejuvenated, perhaps forming rapids or falls, due to geological features.
Physical Aspects	a) Bedrock: Exposures of bedrock; particularly resistant metamorphic or igneous rocks and boulder or coarse gravel bottom. b) Soil: Sand and gravel with some organic material, often mobile due to water flow. c) Relief: Usually associated with mountainous or hilly country giving steep stream profiles. d) Water Conditions: Fast flowing, well-aerated water with low silt load. Chemical composition including dissolved nutrients will depend upon bedrock geology. Often show marked changes in water level due to seasonal rainfall.
Ecosystem	Primary production is low within the habitat as adverse conditions restrict plant growth (coarse, mobile substrate). Production from aquatic plants and marginal terrestrial vegetation is soon exported. Populations of consumer organisms (mainly particulate feeders) are low. The quality of the system may be adversely affected by temperature increase when shade trees are removed from the banks.
Successional Sequence	The rapidly flowing, young stages of streams will always be present as the river erodes the landscape. Over time the young stage will mature into a slow moving stream, but may be rejuvenated when a geological obstacle is encountered.

Plants

The fast flowing water, bedrock substrate and mobile boulders and gravel present difficulties for plant growth. Microscopic and filamentous algae occur on the rock surfaces and there may be dense growths of liverworts and mosses (eg. Fountain Moss) especially near the banks. The flowering plants; Bur-reed (*Sparganium*) and pond weed (*Potamogeton*) are firmly rooted into the gravel bottom and have narrow leaves to provide least resistance to the current. The specially adapted Threadfoot (*Podostemum ceratophyllum*) which closely adheres to rock surfaces has recently been discovered in rapids in the LaHave River. Emergent aquatic plants may be found along the banks where the current is reduced.

Animals

The aquatic animals are all well adapted to withstand the fast current and seasonal variations in water level. The most important invertebrates are the larvae and nymphs of insects particularly stoneflies, caddisflies and dragonflies. Blackfly larvae develop in the well aerated water and form their pupae on the leaves of submerged plants. Other invertebrates include the sponge (*Spongilla*) and freshwater mussels such as *Margaritifera* which are found in patches of gravel. The larvae of river mussels are parasitic on the gills of fish, an adaptation that counteracts the tendency for populations to be flushed downstream by the current.

The well aerated water and food supply of insect larvae make the habitat well suited for fish such as trout. At low water levels these fish are concentrated in pools.

Special Features

1. River rejuvenation including the occurence of rapids and falls, especially significant along the Atlantic Coast.
2. The special adaptation of plants and animals to resist current flow and maintain their populations in the river.
3. Trout and salmon occurences.
4. The heating effect of shade removal due to tree cutting.

Distribution in Nova Scotia

Rapidly moving streams occur throughout the province in upland areas; Cape Breton Highlands (regions 100 and 200), Cobequid Hills (region 300), North Mountain (district 710), South

Mountain (district 420), etc. Slow moving streams flowing to the Atlantic Ocean are rejuvenated as they pass through the Meguma quartzite near the Atlantic Coast, region 800 (eg. Musquodoboit River, St. Mary's River).

ASSOCIATED TOPICS

T11 to T14 Landscape Development; T29 to T30 Surface Waters.

ASSOCIATED HABITATS

H12 Slow-moving Streams

REFERENCES

Sabean (1976, 1977)
Wright (1972)

H14 Blanket and Raised Bog

A bog is a mossy peat-covered or peat-filled wetland either formed on an undulating rocky substratum consisting of ridges and depressions or formed as the result of infilling of a lake or pond (transition bog).

Formation

Bogs are formed in depressional areas of glacial origin in a climate where precipitation is greater than evaporation. This habitat is an unbalanced system in that the rate of production or organic matter is greater than the rate at which this organic matter is decomposed. The result is the building of layer upon layer of acidic sphagnum moss "peat". Several bogs may coalesce to form a "blanket" bog.

Physical Aspects

a) Bedrock: variable, but usually hard igneous and metamorphic rocks
b) Soils: organic peats
c) Relief: depression or flat
d) Drainage: very poorly drained, water table always at or near the surface.

Ecosystem

The bog surface is sometimes flat but more often than not raised towards the center and is virtually unaffected by the nutrient-rich ground water from adjacent forest habitats. Water of the bog environment, which is almost entirely in the form of rain, is usually extremely acidic and low in nutrients. The dominant peat material is Sphagnum moss with sedge peat contributing a minor portion to the bog's structure. The bog may have trees or be treeless with the ground surface covered with Sphagnum mosses and ericaceous shrubs. Productivity is low due to exposure and low nutrient level.

Successional Sequence

The process of progressive in-filling of depressional areas in bedrock, or the in-filling of shallow lakes and ponds has resulted in the formation of bogs. The successional stages from ponds and lakes to black spruce forest quite often exist, particularly here in Nova Scotia, as bogs - the late successional stage of the water-to-land process.

In the damp, poorly drained depressions the peat-forming mosses of the Sphagnaceae family become established. As the layers of peat (the decomposed remains of the moss) begin to accumulate, the surface vegetation of the depressional areas spreads laterally. With the accumulation of organic matter, vascular plants invade the habitat, especially the bulrush (Scirpus cespitosus). Once this species becomes established, bog development really begins. A layer of compact sedge and sphagna peat impedes the local drainage and thus produces a "bog meadow", an early successional stage in bog development. As the damp conditions continue, so does the vigorous and robust growth of the Sphagnum species. Sphagnum tenellum is one of the first colonizers of the damp depressions. This species forms low-lying mats upon which, successionally, the cushion-forming Sphagnum species (S. capillaceum, S. magellanicum, and S. pulchrum) become established. At this point, these cushion-forming species bring about important changes. This new peat becomes waterlogged which in turn causes a restriction in air circulation. This results in a depletion of oxygen needed in the process of decomposition and thus the dead plant material decomposes very slowly. Peat accumulation is therefore greatly accelerated, so much so that the bog takes on the appearance of a "wet bog" characterized by very wet surface conditions maintained by the abundance of cushion-forming Sphagnum species.

As the various Sphagnum species have different growth rates, the surface of the bog begins to take on a hummocky appearance as well as causing a corresponding rise in the water table. The hummocks may eventually coalesce to form ridges with an enclosed depressional area, which, because of the rising water level, and the impermeable layer of sedge peat beneath, eventually forms a pond.

As the bog surface is continually raised due to the growth of the *Sphagnum* hummocks, drier surfaces occur with *Sphagnum capillaceum* and later *Sphagnum fuscum* being established. These mesophytic species form very dense compact clumps and eventually replace the cushion-forming species. At this point the climax stage of bog development has been reached and is called a "dry bog".

The "dry bog", being a drier habitat than earlier successional stages, can now support a variety of mesophytic vascular plants. Dwarf larch and, later, dwarf black spruce and ericaceous species become established.

The continued upward growth of the hummocks results in a further drying of the bog surface and lichens, particularly *Cladonia rangiferina* and *Cladonia stellaris* begin to replace the *Sphagnum* mosses. Once the establishment of the lichen colonies are secured, the hummock-forming process is slowed down. The surface of the bog then becomes relatively stablized and eventually the bog will support a Black spruce, Larch forest habitat.

Plants

The vegetation of ombrotrophic (rain-fed) bogs can be grouped under the plant association Sphagnum-Cranberry. This large association can be divided into three sub-associations: *Sphagnum fuscum*; Beakrush - *Sphagnum cuspidatum*; and *Scirpus cespitosus* - *Sphagnum*.

The *Sphagnum fuscum* association occurs over a broad expanse of a bog's surface. It is generally responsible for the hummocky surface of the bog. The association is characterized by three layers: a poorly developed dwarf shrub layer consisting of Black Spruce and Larch and heath vegetation; a moderately well developed herbaceous layer containing Crowberry, Bakeapple, Bunchberry, Blueberry, Goldthread and Starflower; and finally, a well-developed moss and lichen layer with Schreber's moss (*Pleurozium schreberi*), Sphagnum moss (*Sphagnum fuscum*), and the reindeer mosses (*Cladonia rangiferina* and *Cladonia stellaris*) as the dominant plant species.

The Beakrush - *Sphagnum cuspidatum* is the common plant association found in the depressional areas of the bog's surface. These habitats are, for the most part, small and often referred to as "muck mats". These mats are composed of densely interwoven roots and decomposing material producing a flat, mucky, impervious surface in which rainfall can collect. Evaporation is the primary means by which this water is removed from the depressional muck mat. Beakrush is the dominant plant species with the Narrow-leaved Sundew as a sub-dominant. *Sphagnum cuspidatum* and *Sphagnum pulchrum* are common; as is Bladderwort (*Utricularia cornuta*), Large Cranberry, heath shrubs, Small Cranberry, and the liverwort *Cladopodiella fluitans*.

The *Scirpus cespitosus*-*Sphagnum* sub-association is common on raised bogs and along the outer edges of bogs adjacent to the stunted Black Spruce forests, particularly frequenting small erosional channels. The dominant species are th *Sphagnum* mosses and the Bulrush (*Scirpus cespitosus*).

Other plant species well represented in this habitat include many of the heath plants, lichens such as *Cladonia rangiferina*, *Cladonia pleurota*, and *Cetraria islandica*, Chokeberry, sedge (*Carex oligosperma*), *Calamagrostis pickeringii*, as well as many of the herbaceous plants represented in the two previous sub-associations.

Plants that catch and digest insects are commonly found in bogs and are able to supplement the poor nutrient supply of the habitat. Beside the Bladderwort and Sundew previously mentioned the Pitcher Plant is a common species in bogs throughout Nova Scotia.

During June and July most bogs show a conspicuous display of orchids; Paper-white Orchid (*Habenaria blephariglottis*), Swamp-pink (*Pogonia ophioglossoides*), Grass-pink (*Calopogon pulchellus*) and Bog-pink (*Aresthusa bulbosa*). The last two species are widespread in Nova Scotia, but relatively rare.

Animals

The acidic and low productivity conditions in bogs make them unsuitable for many animals. The majority of the invertebrates are insects although other forms such as worms and molluscs occur at the bog margins. The aquatic insect fauna is depauperate and consists largely of water midges. Associated with sphagnum is a highly specialized beetle fauna comprised of very small ground beetles and rove beetles. Pitcher plants support specialized insects including the Pitcher plant midge, Pitcher plant mosquito, Pitcher plant moths; Exyra rolandiara in pitchers, Olethreutes daeckeana in flower heads, Papaipema appassionata in roots. Ericaceous vegetation supports a variety of typically bog Lepidoptera including the Bog Copper Butterfly, the Bog Elfin, Arctic Jutta Butterfly and many moths.

Several species of amphibians and reptiles can occur in the bog, especially frogs which breed in the bog ponds. Of particular interest are the Four-toed Salamander which breeds in wet Sphagnum and the rare Blanding's Turtle that is associated with bogs in Kejimkujik National Park. Many species of birds and mammals may be seen in bogs but only a few are real residents. Of nine resident passerine birds all but one are warblers which need to nest in shrubs or trees at the bog margin. Rusty Blackbirds nest in shrubs near open water and Black Duck may be seen in larger ponds. Small mammals never reach high population levels in bogs. The Cinerous Shrew is typical. Larger mammals such as Muskrat, Moose and Black Bear may be seen around bog margins.

Special Features

1. Alkaline bogs
2. Rare plant species (Arctic-alpine relics)
3. Unique habitat dominated by vegetational processes.
4. Insectivorous plant (Bladderwort, Sundew, Pitcher Plant)

Distribution in Nova Scotia

Bogs, in various stages of development, are scattered throughout the province, particularly in the hard rock regions 100, 200, 400 and 800, but also in depressional parts of the softer rock regions especially districts 550 and 590.

ASSOCIATED TOPICS

T16 Colonization by Plants, T17 Colonization by Animals, T29 General Hydrology, T32 Soil Classification, T38 Lichens, T39 Bryophytes, T43 Plant Communities.

ASSOCIATED HABITATS

H8 Coastal Freshmarsh, H9 Dune System, H10 Freshwater Pond, H11 Freshwater Lake, H15 Fen, H17 Barren, H33 Black Spruce, Larch Forest.

REFERENCES

Erskine (1957)
O'Brien and Hudgins (1978)
Science Section Staff, N.S. Museum (1978)
Wright (1972)

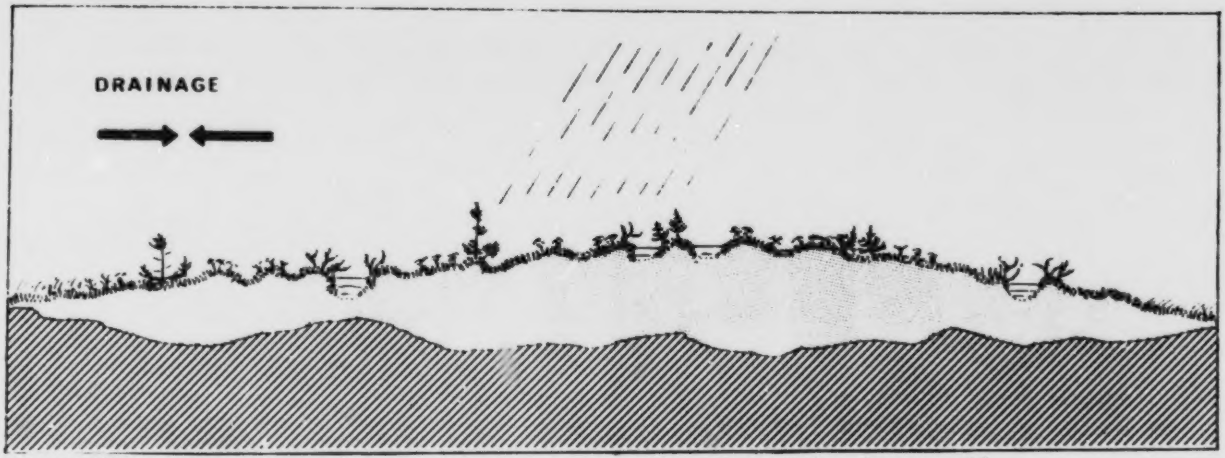


Fig. 98. Diagramatic section of an ombrotrophic (raised) bog showing the elevated surface and internal drainage.

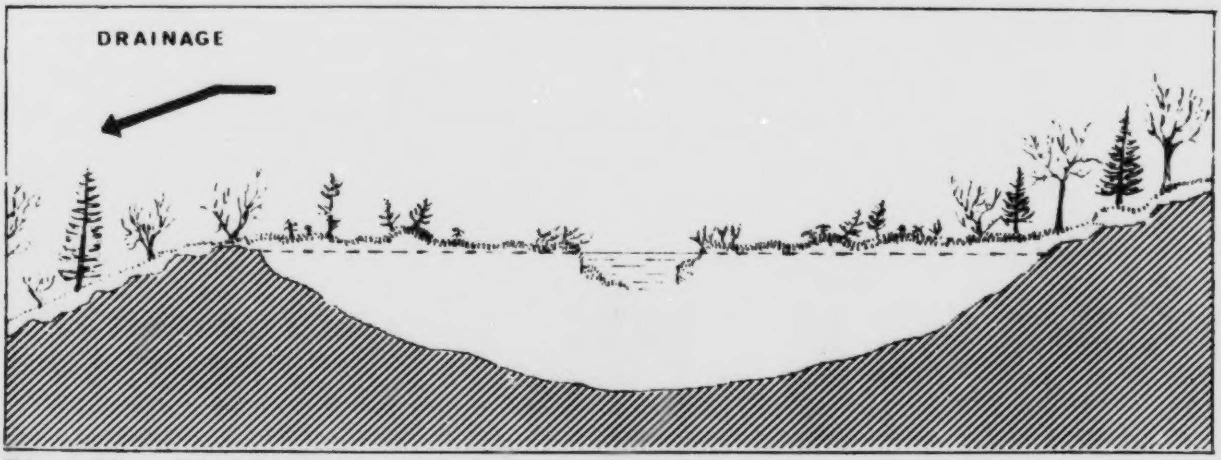


Fig. 99. Diagramatic section of a transition bog showing the level surface and external drainage.

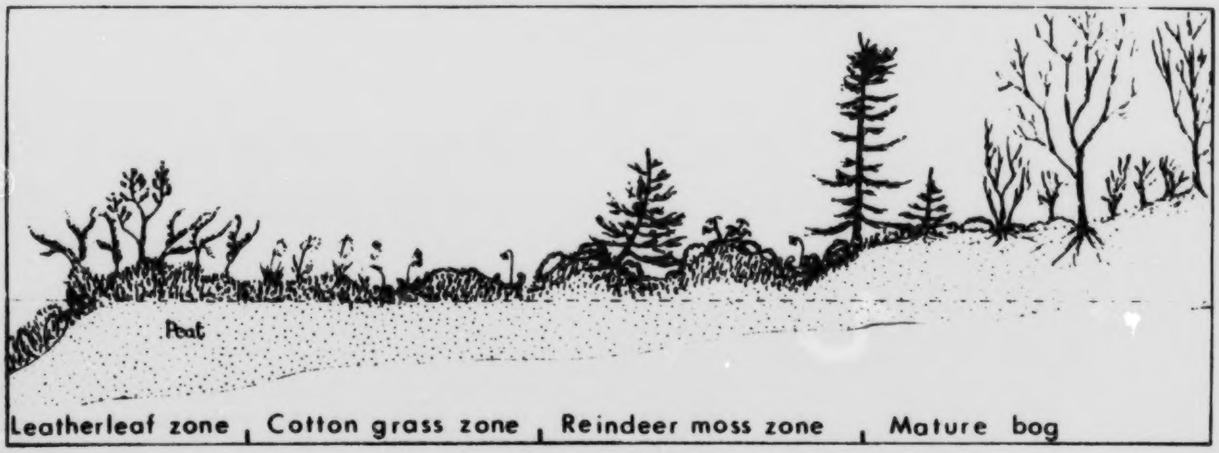

Peat
Leatherleaf zone
Cotton grass zone
Reindeer moss zone
Mature bog

Fig. 100. Zonation of vegetation reflecting successional stages in a bog.

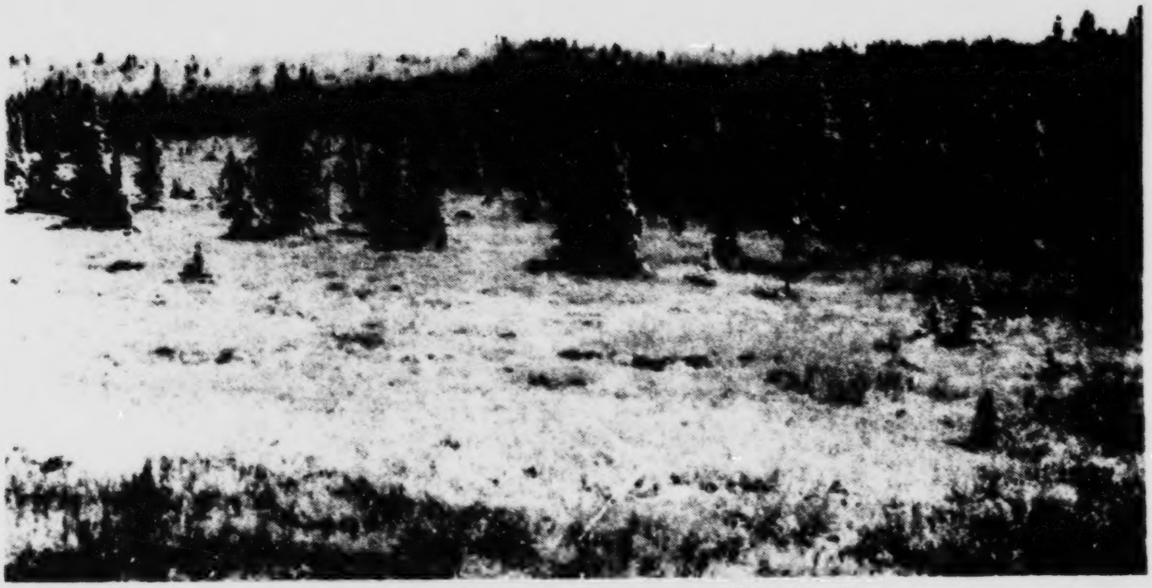


Fig. 101. A Raised Bog (ombrogenous bog) (H14), in Halifax Co. with developing black spruce-larch forest (H33). The forest on the distant ridge is largely maple-oak, birch (H22).
Photo: R. Merrick

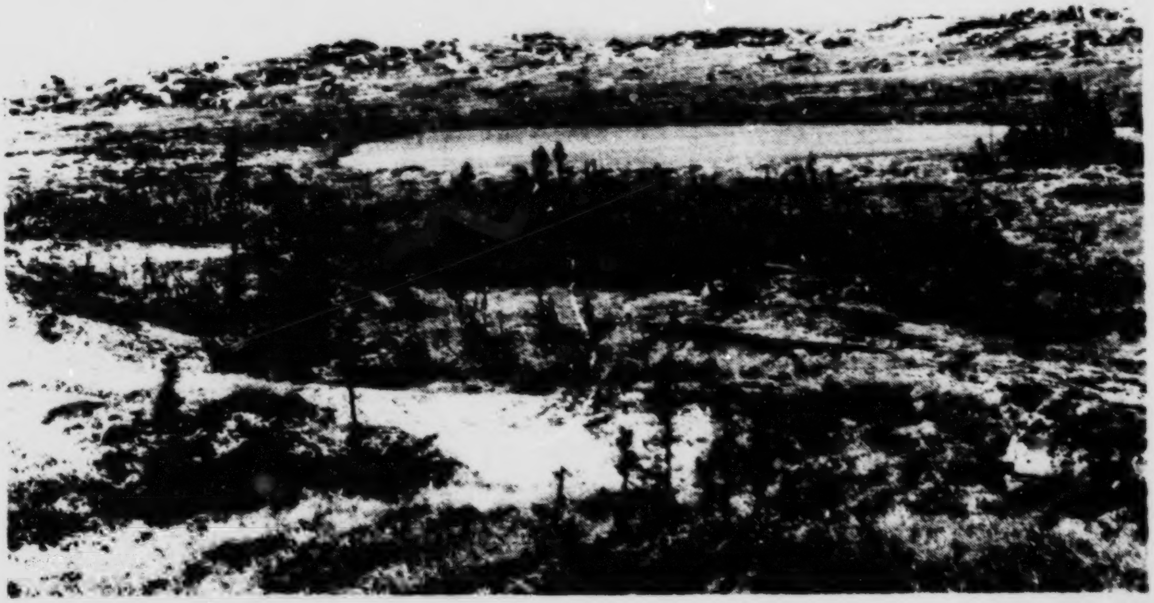


Fig. 102. Barren (H17) and Blanket bog (H14) near Peggy's Cove, Halifax Co. Note the stunted trees associated with this exposed location.
Photo: R. Merrick

H15 Fen

A fen is a sedge peat-covered or peat-filled wetland along lake edges and river banks with a seasonally fluctuating and nutrient-rich water levels and covered predominantly with sedges and grasses.

Formation	Fens are generally found bordering slow-moving rivers and streams and lakeshores. The fen is usually only a few centimetres higher than its associated water body and thus is occasionally inundated by seasonal high waters. The small amounts of sediment which load waters deposit on the fen surface have a direct effect on the composition of the vegetation.
Physical Aspects	a) Bedrock: variable b) Soils: generally organics overlying coarse textured sands and gravels. c) Relief: in flat to depressional areas particularly around lakeshores and river and stream courses. d) Drainage: well to poorly drained.
Ecosystem	Primary production is mainly carried out by grasses and much of the material produced accumulates on the site as peat. The mineral soil base on which the fen develops and periodic inundation by mineral rich river water make this a moderately productive habitat. However, silts associated with the flooding inhibit the growth of some plant species and limit the diversity of consumer organisms.
Successional Sequence	Since the fen habitat is heavily dependent on the soil characteristics of the site, especially flooding and sediment deposition, successional changes within this habitat can occur only as the flood frequency changes. This may occur as the stream channel itself becomes modified, through an elevation in the peat surface, or as additional sediment is deposited from the stream. Should flooding cease, a forest habitat would become established.

However, if drainage somehow becomes impeded and the water level raised, the site will revert to a Scirpus caespitosus - Sphagnum sub-association and a successional series leading to a sphagnum-dominated bog would be initiated.

Plants

The vegetation of a fen is characterized by the Bluejoint Grass - Sweet Gale association. Four sub-associations occupy various surfaces on this floodplain habitat.

The Carex oligosperma sub-association occurs in the deeper depressions of old stream channels and are frequently flooded with standing water present during most of the growing season. Sedge, (Carex oligosperma), and Sweet Gale dominate the herbaceous layer with Bluejoint Grass constantly present. Drepanocladua exannulatus and Sphagnum spp. dominate the moss layer and are indicative of the very wet habitat.

The Bluejoint Grass (Calamagrostis pickeringii) sub-association occurs in old stream channels and the shallow depressions resulting from the in-filling of old cut-off ponds but at a higher relief than that of the sedge sub-association. The surface is submerged only during floods. Grass dominates the vegetation with characteristic species such as Sweet Gale, Bog Goldenrod, Bog Laurel and the sedge Carex oligosperma. Sphagnum spp. dominate the moss layer.

The Bluejoint Grass (Calamagrostis canadensis) sub-association develops along levees of both the present and older stream channel and on hummocky surfaces of the floodplain due to continuous peat deposition. It is submerged only during flooding and then only briefly. This sub-association has two layers: a poorly developed shrub layer consisting of Mountain Fly-honeysuckle, Meadow Sweet and Sweet Gale, and a well developed herbaceous layer with Bluejoint Grass and the aster (Aster radula) as the dominant species and Rough Goldenrod, Meadow-rue, Blue Flag, and Marsh Cinquefoil as sporadically occurring species.

The Sweet Gale-Blue Flag sub-association is restricted to the banks of the stream and the edges of cut-off ponds. Moving or standing water is usually present most of the year. The well developed shrub layer is dominated by Sweet Gale, Mountain Fly-honeysuckle, Meadow-sweet and Bog Laurel. The herbaceous layer contains Blue Flag, Aster nemoralis, Northern Manna-grass, Carex aquatilis, Carex rostrata, Carex interior, Carex oligosperma, Carex paupercula. Sphagnum mosses dominate the moss layer. A conspicuous plant of this habitat in Cape Breton and northern Nova Scotia is Joe-pye-weed.

Animals

There is a rich fauna of deer-flies, horseflies and mosquitos in wet mud and shallow, still water. In deeper channels the animals are the same as are found in ponds. Lepidoptera associated with grasses, sedges, etc. are largely Crambidae, small white pyralid moths, and Leucania species. Terrestrial molluscs include Succineidae and Zonitoides nitidus, and the Slug Deroceras laeve.

Amphibians which breed in local ponds may be commonly seen. Bird species include the Virginia Rail, swallows, flycatchers, Yellow Warbler and Swamp Sparrow. The mammals include Cinerous Shrew, Water Shrew, Arctic Shrew, Star-nosed Mole and Muskrat. Many other species would be encountered entering the fen from adjacent habitats.

Special Features

1. nutrient-rich wetland,
2. abundance of wildlife species,
3. flooding.

Distribution in Nova Scotia

Fens are scattered intermittently along the lower reaches of rivers and lakeshores of the province, especially in lowland areas of regions 400, 500 and 600.

ASSOCIATED TOPICS

T29 and T30 Surface Waters, T43 Plant Communities.

ASSOCIATED HABITATS

H8 Coastal Freshmarsh, H10 to H13 Freshwater Habitats, H14 Bogs, H16 Swamp.

REFERENCES

Eastern Ecological Research (1978)
Rubec and Pollett (1980)

H16 Swamp

A peat-filled area or a mineral wetland with standing or gently flowing waters occurring in pools and channels. Characterized by an open tree cover of Balsam Fir, Black Spruce, Red Maple, Larch and numerous woody shrubs (Alder, Canada Holly, Witherod, etc.).

A swamp is a depressional area surrounded by higher ground. It is characterized by a nutrient-rich high water table (and sometimes standing water) as a result of seepage slopes or springs supplying water from the higher ground into the basin. However, there is usually an outlet such that the swamp is generally well drained. Also hummocks are formed from the decomposition of mosses and herbaceous plants, providing a drier site on which tree species such as Black Spruce, Larch, and Red Maple can become established.

Formation	Swamps originated in one of two ways; either through the infilling of lakes or as the result of the relationship between topography and ground water level, that is the presence of springs or seepage from higher ground.
Physical Aspects	a) *Bedrock*: variable, b) *Soils*: a combination of organics overlying mineral soil; sometime organics being totally absent, c) *Relief*: depressional area with outlet through surrounding higher ground, d) *Drainage*: seepage slopes and springs; usually well to imperfectly drained.
Successional Sequence	The early successional stages of a swamp are dominated by the bryophyte layer notably having the following species: *Sphagnum* spp , *Marchantia polymorpha*, *Mnium punctatum*, *Pallavicinia lyellii*, *Pellia epiphylla*, *Philonotis fontans*, and *Scapania nemorosa*. However, several prominent herbaceous species such as Sensitive Fern, sedges (*Carex* spp.), bulrushes (*Scirpus* spp.), rush (*Juncus* spp.), and manna-grasses (*Glyceria* spp.) become well established during this early stage.

The mid-successional stage of the swamp is dominated by a luxuriant growth of grasses, sedges, rushes and herbaceous species. Prominent among these are Cinnamon Fern, Royal Fern, Meadow-Rue, Blue-joint Grass, sedges (*Carex* spp.), Cotton-Grass, Canadian Burnet, (Cape Breton Island), Purple Avens, asters (*Aster* spp.), and fringed orchids (*Habenaria* spp.). The bryophytes are still well represented but more woodland species such as Broom Moss, Schreber's Moss, and *Rhytidiadelphus squarrosus* are numerous. It is in the latter part of this successional stage that shrubs make their presence known, particularly Speckled Alder, Pussy Willow, Sweet Gale, brambles (*Rubus* spp.), Gooseberry, Meadow Sweet, and Witherod.

The climax vegetation of a swamp will eventually approach that which characterizes a forest stand comprising an admixture of Black Spruce, Balsam Fir, and Red Maple (H33 and H34).

Plants

The plant community of the swamp habitat tends to be dominated by the Cinnamon Fern association as this group of plants thrives on moist, seepy but generally well-drained sites. Cinnamon Fern, Sensitive Fern and Sphagnum mosses (*Sphagnum palustre* and *Sphagnum fallax*) dominate the herbaceous and moss layers. Several sedges (*Carex* spp.) are prominent in the wetter areas of the swamp, while woodland herbs tend to clump together on the drier hummocks. Tree species which may be found here include Black Spruce, Specked Alder, Larch, Red Maple.

Animals

The wet condition of the site makes the habitat most suitable for aquatic fauna and amphibians. Although small mammal diversity and abundance in wooded swamps is generally only moderate, there are some localities where well-developed hummocks provide sufficient living space above water to support diversities and densities of small mammals equal to those in similar but well-drained habitats. Birds include Swamp Sparrow, Common Yellowthroat, and aerial foragers such as Tree Swallows, Chimney Swifts, Common Nighthawk and Barn Swallows. Warblers become more numerous in older and more advanced stages of tree cover.

Special Features	1. seepage slopes and springs, 2. variety of fauna and flora.
Distribution in Nova Scotia	The swamp habitat is found throughout the province.

ASSOCIATED TOPICS

T42 to T46 Vegetation.

ASSOCIATED HABITATS

H10 Pond, H11 Lake, H31 Balsam Fir Forest, H33 Black Spruce, Larch Forest, H34 Sugar Maple, Elm (Flood Plain) Forest.

REFERENCES

Science Section Staff, N.S. Museum (1978)

TERRESTRIAL UNFORESTED

H17 Barren

Rocky heath-land with dwarf shrub and lichen vegetation.

Formation

Four factors may be involved in the development of barrens:

1) the effects of ice action during glaciation scraping over hard rocks and leaving only a thin residue of coarse till with numerous boulders.
2) the formation of a hardpan layer (ortstein) which is impenetrable to roots.
3) the effects of fire, stripping humus from the soils. Repeated deep burns appear to favour the development of lichen dominated barrens.
4) rigorous climatic conditions.

The extensive barrens of south-west Nova Scotia (district 440 and unit 452) show evidence of repeated burning. In many areas, especially in district 440, the presence of a hardpan may prevent any natural recolonization by trees. Hardpans are also found in Cape Breton Highlands (region 100). The coastal barrens tend to have just a thin, patchy soil cover over bedrock. In many cases the relative importance of fire is not certain - pollen studies in southwestern Nova Scotia suggest that a shift towards shrub vegetation may have started long before European settlement in response to climatic deterioration. Harsh climatic conditions would mostly influence some of the Cape Breton high altitude barrens and coastal barrens on exposed headlands.

Physical Aspects

a) Bedrock: usually granites, quartzites and schists.
b) Soils: thin, coarse, gravelly till over compacted material or bedrock. Low moisture holding capacity strongly acidic.
c) Relief: only moderate changes in elevation, rolling hills, flat areas, ridges (especially over quartzite) and knolls.

d) *Drainage*: usually associated with irregular, sluggish, meandering streams, with peat accumulation and oligotrophic bog formation in depressions.

Ecosystem

Barrens are essentially impoverished habitats, with low nutrient availability and low floral diversity, offering a comparatively small number of niches.

Successional Sequence

The present successional status of barrens may depend largely on the role of fire in their development - which cannot always be determined. On many sites the shrub-lichen vegetation may represent the climax stage as related to the existing soil conditions. Change would only come about very slowly as a result of soil development. On other sites, if fire does not intervene some form of dwarf Black Spruce forest cover may eventually develop.

Plants

Barren conditions favour ericaceous (heath) vegetation and lichens. Ericaceous plants are usually woody, acid-tolerant and very resistant to drought. Lichens are a pioneer vegetation type, in this case colonizing exposed rock. They can also survive very dry conditions.

Coastal barrens: (region 800, especially district 850)	Reindeer moss (*Cladonia* spp.) Broom Crowberry or Black Crowberry
Highland barrens: (region 100)	*Cladonia rangiferina* *Cladonia alpestris* Sheep Laurel Rhododendron Blueberry Black Crowberry Labrador Tea
Inland barrens: (district 440, units 452 and 413)	Broom Crowberry Huckleberry Blueberry Sheep Laurel Reindeer moss Bearberry Rhodondendron

On all barrens some stunted trees may be found, usually Black Spruce or Tamarack. In southwestern Nova Scotia there may also be White or Red Pine. In Cape Breton, Balsam Fir may be found.

Animals	The low diversity of plant types and harsh, dry conditions of the barren do not provide productive habitat for animals. The soil fauna is poor and those that do occur are largely found in protected situations such as rock crevices. Pyralid moths are important and their larvae are common on the low vegetation. The American Toad, Northern Redbelly Snake and Maritime Garter Snake commonly occur. The only bird species commonly nesting in the inland barrens are the Nashville Warbler and Common Yellowthroat. On coastal barrens, particularly on islands, seabirds, such as Leach's Petrel nest. The only mammals that commonly occur are the Cinerous Shrew and Meadow Vole. Other types of bird and mammal will visit barrens from adjacent habitats particularly during the Blueberry season.
Special Features	1. Hummock development: successive layers of lichens growing up through shrubs, smothering the branches, gradually build up hummocks composed entirely of incompletely decomposed humus. 2. Krummholz: stunted tree growth resulting from the combined effects of poor site conditions and harsh climatic exposure. Trees exhibit dense, lateral branching. 3. Polygonal patterns (Southwestern Nova Scotia): Lines of small boulders which have been preferentially sorted in late glacial and immediate post-glacial time by freezing and thawing.
Distribution in Nova Scotia	Major coastal barrens are found in Halifax County and Guysborough County (district 850). Other large barren systems are in the Cape Breton Highlands (region 100); to the east of the Liscomb Game Sanctuary (unit 413b); Shelburne County (unit 452) and the Tobeatic Game Sanctuary (district 440).

ASSOCIATED TOPICS

T35 Hardpans, T43 to T45 Vegetation, Succession.

ASSOCIATED HABITATS

H15 Bogs

REFERENCES

Eastern Ecological Research (1978)
Martin (1956) (1959)
Nicols, (1918)
Strang, (1969)

H18 Oldfield

Associated with the farming industry in the past. Oldfield habitats originate from cultivated land and pastures.

Formation

The field habitat has been with us since the Europeans immigrated to the province's shores. Originally forested areas in lowland areas, the first settlers cut and burned vast areas in order to grow crops for themselves and their livestock. When abandoned these fields rapidly return to a forest condition.

Physical Aspects

a) Bedrock: predominantly sedimentary and volcanic rocks
b) Soils: variable but usually deep sandy to clay loams; soil horizons have been lost due to ploughing.
c) Relief: mostly flat to gently rolling topography
d) Drainage: imperfect to well-drained.

Ecosystem

The field habitat results from the human activities associated with food production on a relatively large scale. Cultivated fields and livestock pasture are the active forms of this habitat while old, abandoned fields soon revert to a forested habitat. Cultivated plant species and weed species dominate the habitat.

Successional Sequence

The course of secondary succession subsequent to cultivation is described under the term fallow fields. With the cessation of plowing the vegetation of open fields quickly reverts to an annual, then a perennial weed community. Common species include Sheep-Sorrel, Spurry, Broad-leaved Plantain, Narrow-leaved Goldenrod, Yarrow, Dandelion and Canada Thistle. The perennial grasses - Wire-Grass and Kentucky Bluegrass appear in the early successional stage and become dominant as time goes on. The moss, Polytrichum also becomes prominent in the development of a continuous turf.

At this point in the succession of field-to-forest, the vegetation for fallow fields closely approximates that of the abandoned fields. Along with the perennial grasses and weeds of the fallow field, herbaceous perennials such as Wild Strawberry, Creeping White Clover, and Everlasting are common. Eventually these neglected fields become infested with shrubs such as Common Juniper, Raspberry, Blueberry, Pussy-willow, Downy Alder and Meadowsweet.

Tree species invade the abandoned field at an early stage. Numerous young conifer seedlings can be seen growing among the tall grasses and weeds. If left undisturbed for several years, an abandoned field will revert to a White Spruce forest.

Plants

Fields are cultivated for the purpose of providing food for man and his livestock. Vegetables and fruits are grown to meet man's own needs while hay and grains are generally grown to provide livestock with added nutrition.

Pastures are usually grass-dominated fields used for providing livestock with feed during the summer months. Livestock are generally set loose, in fenced enclosures, to graze at will. Common grass species found in pastures are Kentucky Bluegrass, Bentgrass, Timothy, and Red Fescue.

Old fields are those which have been neglected and abandoned for one reason or another. This abandonment results in the beginnings of a successional sequence that soon results in the re-establishment of a forest. Mosses, perennial weeds, and shrubs are plentiful.

Animals

The animals present depend upon intensity of cultivation or the duration of neglect. In the monoculture condition, invertebrates are few. Abandoned fields have largely insects and spiders. Many of the soil organisms are introductions from Europe, especially slugs and earthworms. Toads, Leopard Frog, Pickerell Frog, Eastern Smooth Green Snake, Northern Red-belly Snake and Maritime Garter Snake may be common. Many bird species forage in the habitat but nest in adjacent woodland. High invertebrate populations in alder succession attract insectivorous species. The diversity of species increases as forest regeneration proceeds. Typical birds include the Savannah Sparrow, Bobolink, Robin, Ruffed Grouse and Woodcock. Hawks and owls hunt for small mammals in the open areas. Mammals include Meadow Jumping Mouse, Common Shrew, Meadow Vole, Snowshoe Hare, Deer and Bear.

Special Features

1. Succession from abandoned field to forest.
2. Garden escapes; plants from old gardens surviving in a natural habitat.
3. Ragwort and Cinnabar Moth in northern Nova Scotia.

Distribution in Nova Scotia

The field habitat is abundant throughout the province, generally wherever settlement has taken place but particularly in region 500. Over 2 million acres are known to have been cleared at the end of the 19th Century. Less than 1/2 million acres of cleared land are actively worked by farmers today.

ASSOCIATED TOPICS

T15 to T17 Colonization, T31 to T35 Soils, T43 Plant Communities and T45 Successional Trends.

ASSOCIATED HABITATS

H26 White Spruce Forest and H35 Man-made Habitats.

REFERENCES

Nichols (1918)
Daubenmire (1968)
Eastern Ecological Research. (1978)
Scott (1972)

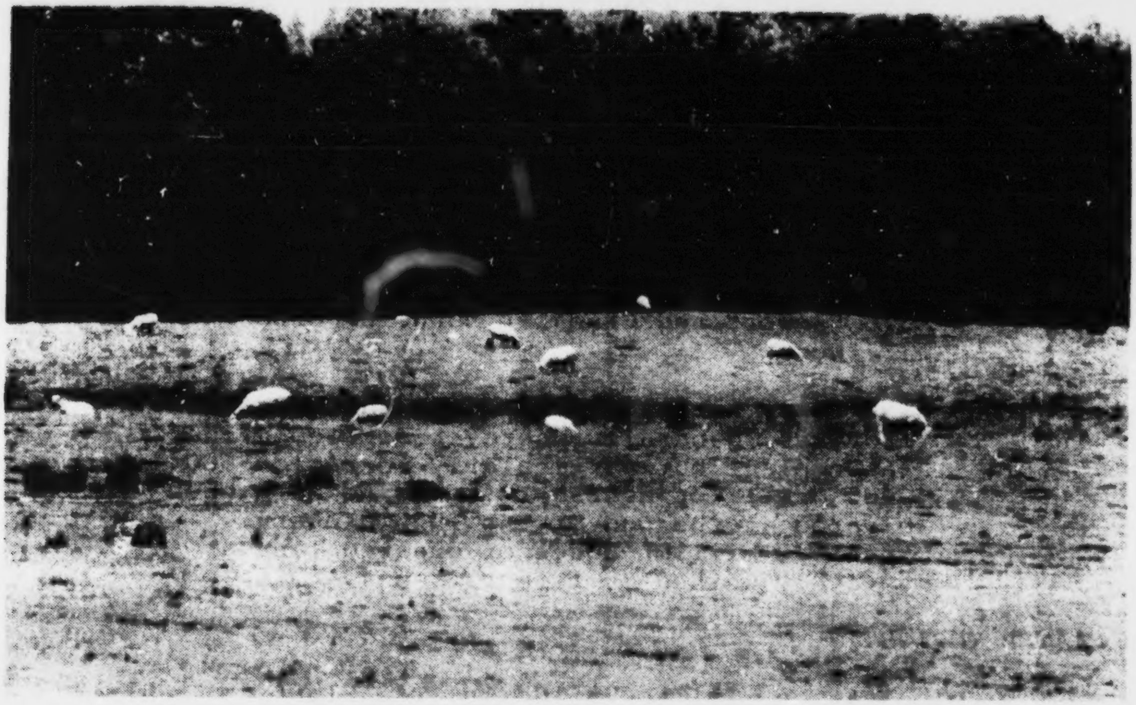


Fig. 103. A field used as a sheep pasture, with spruce, fir-maple woodland (H30) in the background, Musquodoboit Valley, Halifax Co.
Photo: F. Scott

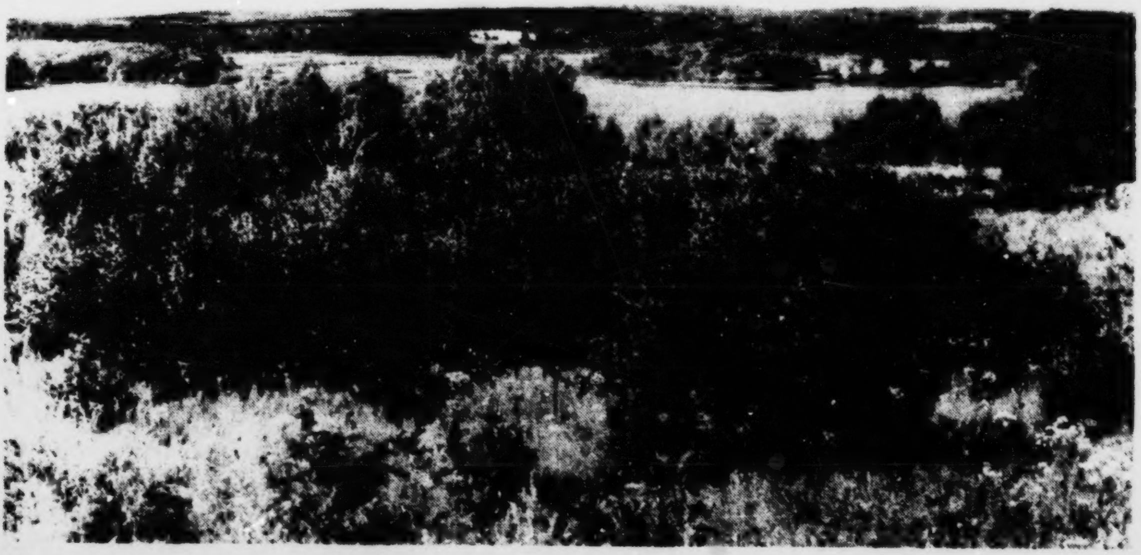


Fig. 104. Alders growing in an old field (H18). St. Mary's River Valley, Pictou Co.
Photo: R. Merrick

H19 Cliff

Very steep to vertical faces of bedrock outcroppings.

Formation	Cliff habitats have three probable origins: geological faulting and folding, rejuvenation of rivers associated with earlier lower sea levels and coastal erosion associated with modern rising sea level. The result is an elevated bare precipitous mass of rock outcropping.
Physical Aspects	a) Bedrock: variable, b) Soils: bedrock outcrops with crevices filled with soil, c) Relief: steep hilly or mountainous topography, d) Drainage: north-facing cliff generally moist to dripping wet while south-facing cliff tends to be dry. Conditions occurring on east - and west - facing cliffs dependent on local climatic conditions. e) Salt Spray: on sea cliffs in exposed situations.
Ecosystem	This habitat is probably one of most severe types of bare area to be colonized by plants. For a long time only crustose lichens will be present with herbaceous and a very few tree species finally occupying a very tenuous existence in crevices. Generally speaking these cliffs are too rocky and steep to support a forest stand.
Successional Sequence	As best can be determined the lichen-bryophyte-fern community constitutes the climax vegetation on cliff habitat. The nature of the habitat would have to be radically altered through geological processes over an extended period of time in order to produce a more elaborate successional sequence than the present plant community.
Plants	Because there are varying degrees of intergradation between hydric (wet) and xeric

(dry) cliffs, it is not surprising to find a common group of plants associated with both extremes. This common group is comprised of the bryophytes and lichens which thrive in crevices and frequently blanket even precipitous rock surfaces. The crustose lichens include Lecanora spp., Lecidia spp., Buellia spp., and Rhizocarpon spp.

Foliose lichens such as Parmelia spp., and Gyrophora spp. and fruticose lichens such as Cladonia spp. and Stereocaulon spp. are usually present. Many mosses and liverworts are common in this habitat, for example, Bartramia pomiformi, Hedwigia ciliata, Radula complanata, Porella platyphylloides, Plagiochila asplenioides, and Plagiopus oederiana. Certain ferns are also characteristic; Rock Polypody, Common Bladder Fern, and Rusty Woodsia. Fir Club-moss is also characteristic of this habitat. Hair-grass and Harebell are frequent herbaceous species. This habitat may also harbour many of the rarer arctic-alpine plants.

Animals

Because of the lack of stable soil or small extent of soil in rock crevices, the invertebrate fauna tends to be limited and specialized. Collembola (Springtails), bagworm moths, whose larvae feed on lichens, and predatory beetles feeding on small insects may be found. Some hardy species such as the slug Deroceras laeve may occur accidently.

The most conspicuous species on sea cliffs are sea birds and this habitat is important for nesting of Gulls, Alcids and Cormorants.

Special Features

1. Lichens and to a certain extent, bryophytes have several significant ecological adaptations which permit them to be the first colonizers of rock surfaces. Not only can these non-vascular plants exist without soil as a growing medium but they can also tolerate desiccation for an extended period to the point of becoming brittle.

2. Lichens have the unique distinction of being able to disintegrate rock surfaces chemically by secreting corrosive carbonic acid.

3. Arctic-alpine vegetation.

Distribution in Nova Scotia

Coastal cliffs are found in sections of the Cobequid Hills, Pictou-Antigonish Highlands and Mabou Highlands of district 310; the cliffs, often in basalt, of region 700; the old hard rocks of district 210 and the soft sandstones of regions 500 and 600.

Inland cliffs are found in ravines often on fault lines and near waterfalls, especially in district 220 and regions 300 and 700.

ASSOCIATED TOPICS

T2 to T8 Geology, T16 Colonization by Plants, T26 Coastal Landforms, T27 Shoreline Types, T29 and T30 Surface Waters, T38 to T40 Lichens, Mosses and Ferns, and T53 Seabirds.

ASSOCIATED HABITATS

H12 and H13 Rivers, H20 Talus Slope.

REFERENCES

Conrad (1979)
Daubenmire (1968)
Hale (1979)
Nichols (1918)
Roland and Smith (1969)

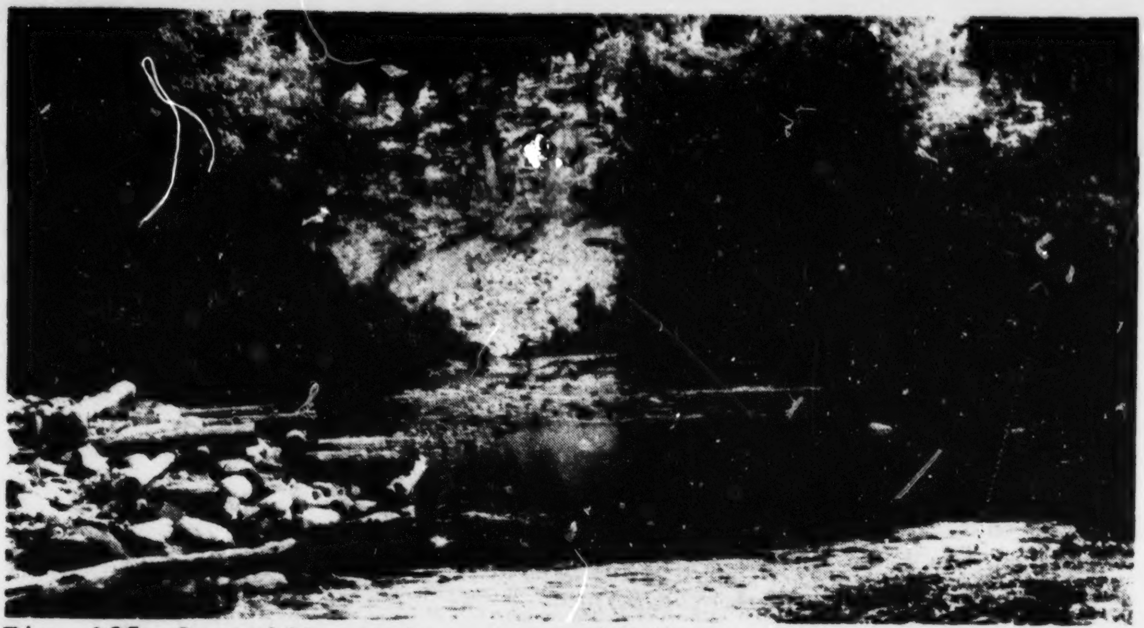


Fig. 105. A rapidly-moving stream (H13) cutting a cliff (H19) in gypsum. Talus slope (H20) occurs at the foot of the cliff and floodplain forest (H34) is also seen. The karstic features of the gypsum include cave habitat (H21). South Maitland, Hants Co.

Photo: F. Scott

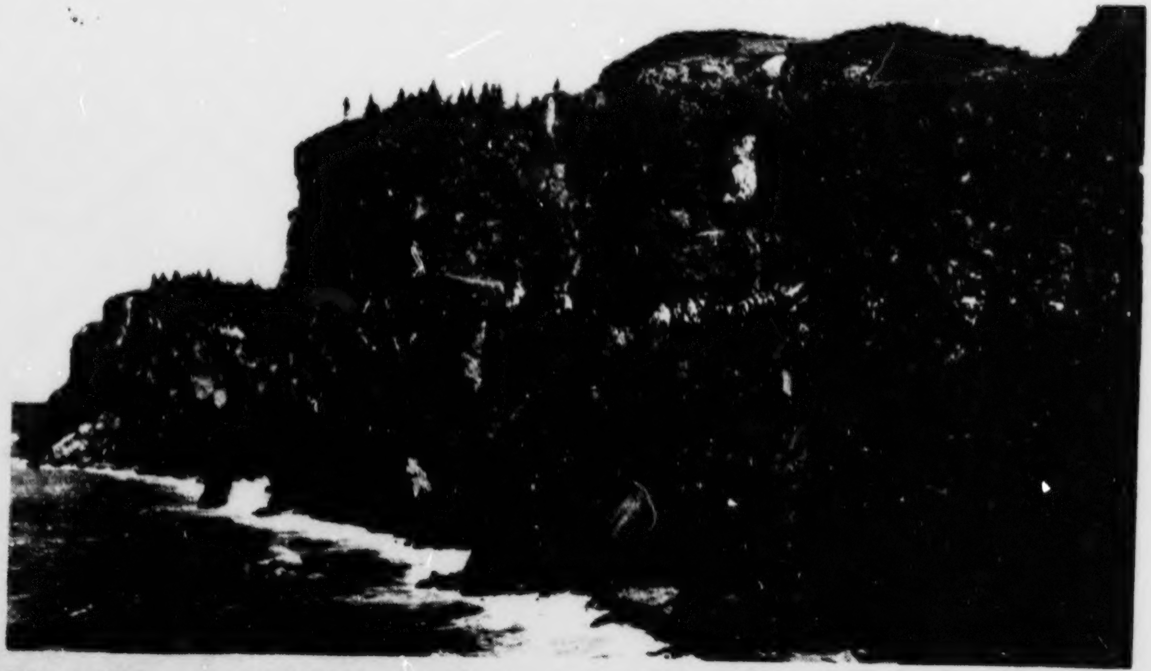


Fig. 106. Sea Cliffs (H19) at Cape d'Or, Cumberland Co.
Photo: T. Randall

H20 Talus Slope

An accumulation of rock debris at the base of a cliff or steep mountain slope and generally, in its early stages of development, so unstable as not to permit vegetative growth other than the primitive non-vascular plants. Also known as scree slopes.

Formation	A talus slope begins with the weathering and mass-wasting of a cliff face in which the loosened rock accumulates at the base of the cliff.
Physical Aspects	a) Bedrock: variable but predominantly hard igneous and metamorphic rock. b) Soils: rock fragments, regosolic soils in crevices c) Relief: Hilly to mountainous topography with steep-sided slopes. Particularly along deeply-incised river gorges. d) Drainage: very rapidly drained; a xeric upper slope as opposed to a more mesic lower slope where the accumulation of finer material and a greater amount of vegetation provides for better water-holding capability.
Ecosystem	Talus, the accumulation of inorganic material at the base of a steep-sided slope, can be found in two extreme forms in Nova Scotia. Boulder talus is characteristic of granitic or other hard rock areas and consists of large boulder fragments which tend to lodge together to form fairly stable sloped surface. A gravel slide on the other hand is predominantly found in soft-rock (sedimentary) and highly fractured metamorphic rock (especially slates), steeply-sloped areas. This talus type consist primarily of loose, finer rock debris not held together and thus constantly moving down-slope. This provides for a very unstable surface. The type of vegetation and its successional sequence is very dependent on the steepness of the talus slope and the type of surface owing to the inability of many plant

species to secure a foothold on an unstable steep rock surface.

Plants

Two types of habitat are available to the plants colonizing a boulder talus - the rock surfaces and the crevices between adjoining rock fragments.

On the rock surfaces, there is little or no successional trend to speak of - this habitat is almost exclusively covered with crustose and foliose lichens. Typical crustose lichens - *Buellia*, *Lecanora*, *Lecidia*, and *Rhizocarpon* spp. - appear on the rock surface first, followed by the foliose lichens *Parmelia* and *Gyrophora*. The fruticose lichen *Stereocaulon* and lithophytic mosses such as *Hedwigia ciliata* and *Grimmia apocarpa* may also be present. *Cladonia rangiferina* may be found in shallow hollows on the rock surface itself, eventually spreading itself outward to cover the entire rock surface. Mixed in with this mat of "reindeer moss" may be the mosses *Rhacomitrium canescens* and *Polytrichum* spp.

The crevices between the rock fragments provide shade, moisture, the beginnings of soil and, as a whole, are responsible for succession within the boulder talus habitat. Here the slow disintegration of larger rock fragments into finer particles along with accumulation of extraneous material results in the accumulation of a soil. Also the lower slope region tends to accumulate more soil more quickly and soil moisture is more abundant. Thus the lower slope crevices tend to be colonized by higher plants first and succession will proceed at a much greater pace here than further up the slope. The crevice habitat can support mesophytes as well as xerophytes. The pioneer plants consist of *Cladonia* spp., and bryophytes such as *Creatodon purpureus*, *Leucobryum glaucum*, *Dicranum scoparium*, *Dicranum bonjeanii*, *Polytrichum piliferum*, *Ptilidium ciliare*, *Pleurozium schreberi*, and *Hylocomium splendens*. This lichen-moss association is an important link in the successional sequence since it provides an excellent seedbed for the vascular plants. Herbaceous and shrub plants are generally sparingly represented by

Polypodium virginianum, *Sambucus pubens*, and *Rubus* spp. However, even more important than herbaceous plants to this habitat is the presence of tree species. In the early stages of talus development with continued dislodging of boulders from above, trees tend to be scattered. As the slope stabilizes somewhat, White Birch is the first to invade the crevices due to its ability to regenerate through stump sprouting, enabling it to recover from the battering force of falling rocks. Later Balsam Fir, White and Black Spruce, Yellow Birch, White Pine and Mountain Ash invade the habitat. Sugar Maple may come into the habitat on the lower slopes.

The second form a talus habitat takes is that of the gravel slide. Due to the high degree of instability, lichens and mosses do not play a significant role in the successional trends of this habitat. The more important pioneer species include the xerophytic plants such as Wire Grass, Harebell, Pearly Everlasting and White Goldenrod. Most of the common weed species found on pastures and along roadsides can be found in this habitat. Wire Grass, Brambles (*Rubus* spp.) and White Spruce are particularly important in helping stabilize the slope material. Continued instability due to undermining the base of the talus slope by a river or the sea may prevent colonization from ever proceeding further. Eventually a closed canopy of conifer trees may develop, if stable conditions occur, which in turn may be superseded by a regional climax forest type.

Animals

The animal life is sparse. On rock surfaces it is limited largely to insects and spiders. When a forest develops on a stabilized talus slope the habitat becomes important for land snails, *Zoogenetes harpa*, *Vertigo* spp. etc. and small mammals. In Cape Breton Island these areas are special habitat for Rock Vole and Gaspe Shrew.

Special Features

1. instability of habitat
2. sparse flora and fauna
3. geologic processes

Distribution in Nova Scotia	The talus habitat is found in hilly to mountainous upland areas characterized by steep-sided cliffs and deeply-cut river ravines throughout the province, especially in district 220 and throughout regions 300 and 700.

ASSOCIATED TOPICS

T11 to T14 Landscape Development, T38 to T40 Lichens, Mosses and Ferns, and T43 Plant Communities.

ASSOCIATED HABITATS

H13 Rapidly-moving Stream, H19 Cliff, H27 Sugar Maple, Yellow Birch, Beech Forest.

REFEENCES

Daubenmire (1968)
Eastern Ecological Research (1978)
Nichols (1918)

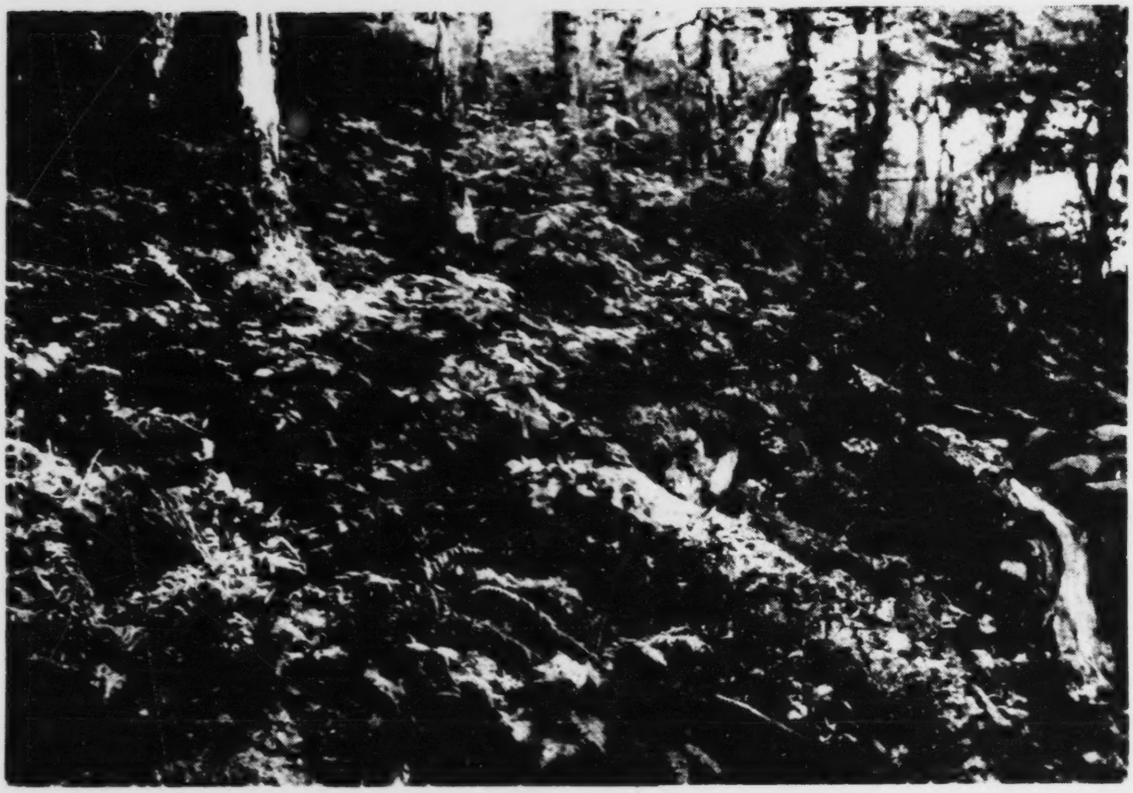


Fig. 107. An old stabilized talus slope (H20) with mature sugar maple, yellow birch, beech forest (H27). Rock Voles and Gaspé Shrew were trapped at this site in 1981. Lewis Brook, Victoria Co. Photo: F. Scott

H21 Cave

Cavities in bedrock caused by solution or erosion by percolating water, flowing water, or wave action. To some extent abandoned mine shafts and tunnels also function as cave habitat.

Formation

Carbonic acid in solution in rainwater disolves calcareous rocks and over long periods of time percolating water will cause the formation of cavities along paths of weakness in the rock. As these cavities increase in size the erosional effect of flowing water becomes more important and eventually a cave will be formed. Sink holes at the surface above the cave are part of the system and with streams, are the main routes by which water, soil and organic material enter the cave (Figure 108).

Shallow caves in sea cliffs, caused by marine erosion alone are never deep enough in Nova Scotia to provide a true cave habitat.

Physical Aspects

a) Bedrock: usually a calcareous sedimentary rock, particularly gypsum or limestone.
b) Soils: Mixed clay and rubble with variable amounts of humus, stratified when deposited by water.
c) Relief: variable, rough due to roof-falls.
d) Drainage: water percolating through the cave roof, often accumulating in pools during wet seasons.
e) Environmental conditions: water has high pH (7.8 at Hayes Cave), air has 100 percent relative humidity and usually constant temperature, 40-48°F (5 to 9°C).

Ecosystem

Because little or no light enters there is no primary production in the cave habitat. The consumer organisms that are found depend upon organic material flushed in by water or brought in by mammals such as bats and porcupines.

Successional Sequence

Small cavities that develop into passages and caves eventually open up to the land surface.

This allows for entry of soil, organic material and animals. With further solution and erosion the cave sytem will eventually collapse and the habitat will be destroyed.

Plants

The lack of light prohibits the growth of green plants. Fungi are usually present on the soil and on decaying organic material (eg animal droppings).

Animals

Soil animals enter the cave accidently and may establish populations similar to those that exist outside of the cave system. So far no distinct soil fauna has been detected in Nova Scotia. Beetles and Springtails are common. Dragonfly nymphs have been observed in cave pools.

Fish are occasionally seen in pools. At Hayes Cave the Threespine Stickleback and an unidentified species of dace (Chrosomus sp.) have been recorded. The dace are slightly different from those seen in other habitats and may in fact be a race, restricted to the cave habitat.

Mammals recorded include bats and porcupine. The porcupines may be common at times and their droppings contribute organic matter to the ecosystem. Bats use caves for hibernation during the winter taking advantage of the constant temperature and humidity conditions. At Hayes Cave the Little Brown Bat is the most common but Keen's Bat and Eastern Pipistrelle also occur. The bats are in the cave from early September until the following June and winter counts have indicated up to 6,000 present throughout the winter.

Special Features

1. The karst topography of sink holes and cliffs in gypsum areas that indicates the presence of caves.
2. The special environmental conditions, low light, alkaline water, high humidity and constant temperature.
3. Hibernating bat populations. Survival of the bats depends upon maintainance of the correct environmental conditions and prevention of disturbance.

Distribution in Nova Scotia

Caves may occur in any limestone or gypsum areas. The best known examples are in the gypsum formations of Hants County and Victoria County (districts 510, 520, 540 and 560). It is believed that there are many other small cave systems, particularly in Cape Breton Island. Abandoned mine workings in Cape Breton (districts 540 and 550) and in the gold districts of the Meguma Group (districts 410, 420 and 430) can also provide cave habitats especially for hibernating bats.

ASSOCIATED TOPICS

T6 The Carboniferous Basin, T11 to T14 Landscape Development, T54 and T55 Mammals.

ASSOCIATED HABITATS

H10 Freshwater Pond, H19 Cliff.

REFERENCES

Gilhen and Scott (1981)
Scott (1979)

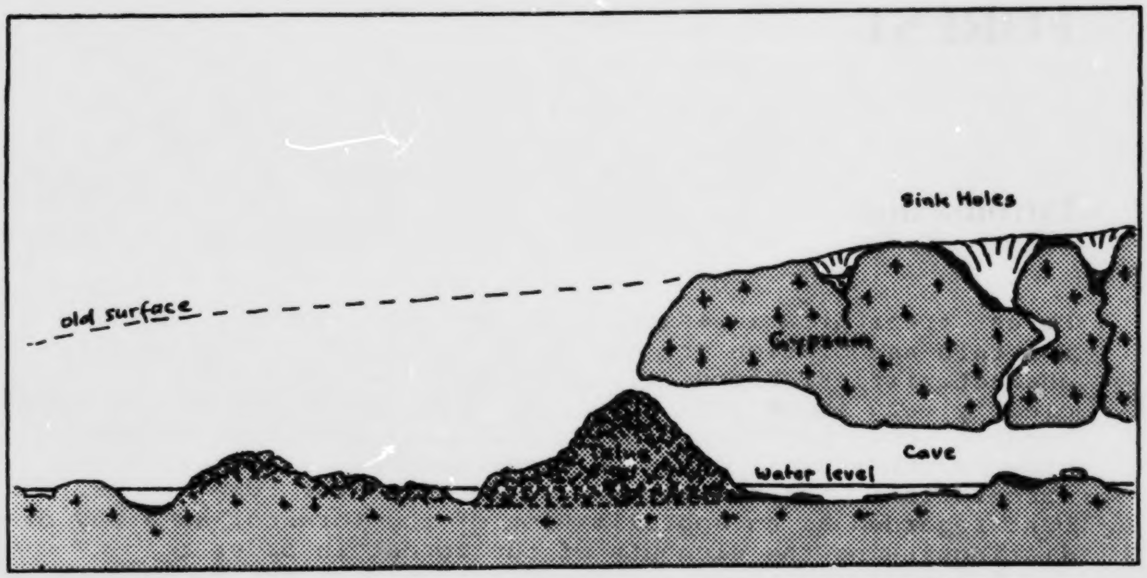

Sink Holes
old surface
Gypsum
Cave
water level

Fig. 108 . The main features of a cave system and karst topography in gypsum. Based upon information from South Maitland, Hants Co. Not drawn to scale.

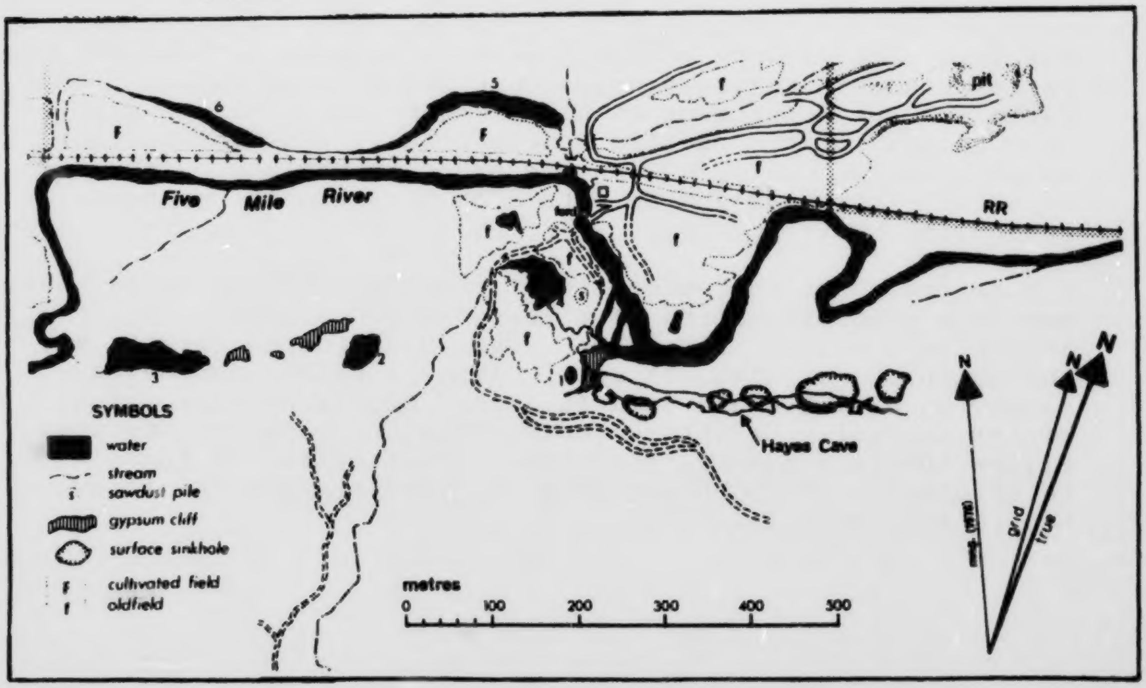

6
5
F
f
pit
Five Mile River
RR
1
2
3
SYMBOLS
water
stream
sawdust pile
gypsum cliff
surface sinkhole
cultivated field
oldfield
Hayes Cave
metres
0
100
200
300
400
500
N
N
N
grid
true

Fig. 109 . The location of the cave system at South Maitland.

FOREST

Introduction

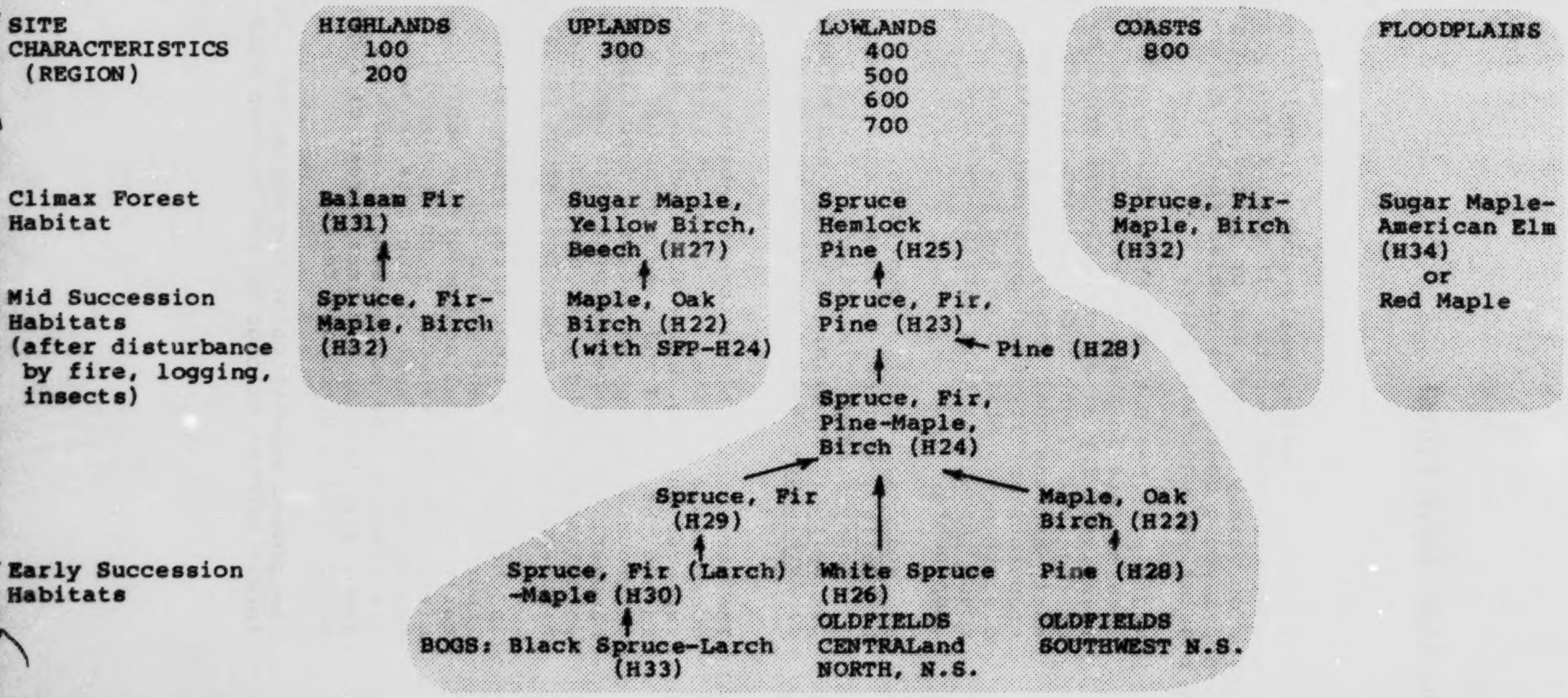
Forest trees grow in association one with another. Reasons for this association are not fully understood although site characteristics, especially shade and soil moisture, are clearly very important. Species which thrive on similar sites tend to occur together. Many individual specimens however grow in other sites and with species other than their usual association. The recognition of forest cover type groups is best regarded as an approximation of the forests; as a way of distinguishing the elements of the forest in order to understand it. Once these cover type groups are recognized they can be used to understand the forests' evolution, its relationship to physical characteristics, other elements of the flora and the fauna.

Fourteen forest habitats are identified here. Their presence has been confirmed by forest inventory mapping carried out for Parks Canada in Kejimkujik and Cape Breton Highlands National Parks and the Department of Lands and Forests through similar inventories in the Tobeatic Game Sanctuary and Cape Breton. An analysis of over 3,000 sample plots maintained by the Department of Lands and Forests also revealed the presence of these same habitats.

Figure 110 shows the successional sequence through which these habitats progress as the 'fit' between the physical environment and the forest matures. Undisturbed forests may result in one of five, or more, climax habitats depending mainly on climatic and soil factors. Disturbance is usual; either naturally or through harvesting and managing forests. Figure 109 is a greatly simplified illustration of these relationships which should help the reader place the forest habitats in context.

Figure 110

SIMPLIFIED FOREST SUCCESSION IN NOVA SCOTIA


SITE CHARACTERISTICS (REGION)
Climax Forest Habitat
Mid Succession Habitats (after disturbance by fire, logging, insects)
Early Succession Habitats
HIGHLANDS 100 200
Balsam Fir (H31)
Spruce, Fir-Maple, Birch (H32)
UPLANDS 300
Sugar Maple, Yellow Birch, Beech (H27)
Maple, Oak Birch (H22) (with SFP-H24)
LOWLANDS 400 500 600 700
Spruce Hemlock Pine (H25)
Spruce, Fir, Pine (H23)
Pine (H28)
Spruce, Fir, Pine-Maple, Birch (H24)
Spruce, Fir (H29)
Maple, Oak Birch (H22)
Spruce, Fir (Larch) -Maple (H30)
White Spruce (H26)
Pine (H28)
BOGS: Black Spruce-Larch (H33)
OLDFIELDS CENTRALand NORTH, N.S.
OLDFIELDS SOUTHWEST N.S.
COASTS 800
Spruce, Fir-Maple, Birch (H32)
FLOODPLAINS
Sugar Maple-American Elm (H34) or Red Maple

The rate of successional change may be approximated by referring to the life span of the species involved, see table 9, T42. An exception is the successional sequence in bogs which occurs more slowly as it depends on changing hydrological conditions, see H14.

H22 Maple, Oak, Birch Forest

This vegetation type is a major, early successional forest habitat of southwestern Nova Scotia. It occurs as a pioneer colonizing type on mainly burned, cut or grazed upland sites. Under its canopy, young coniferous species (pine, fir and red spruce) are regularly found developing.

Formation

Red Maple, Red Oak, and White Birch, all low to intermediate in shade tolerance, invade relatively dry sites recently disturbed by fire or logging. These three species usually form an early-successional forest habitat due to their vigourous ability to stump-sprout following a disturbance. White pine and red spruce may be found throughout this habitat as minor components.

Physical Aspects

a) Bedrock: granite, quartzite, argillite.
b) Soils: shallow, bouldery, sandy loam to loamy sand glacial tills.
c) Relief: drumlinized ridges and hilltops.
d) Drainage: very rapidly to well-drained; dry sites.

Successional Sequence

The maple, oak, birch forest habitat is the consequence of fire. In cases of severe or repeated burning, White Pine and Red Spruce will invade the shaded understory provided by the vigorous sprouting hardwoods. Over time, however, the spruce and pine will become well established in the stand and thus produce a mixedwood or even a pure coniferous forest.

In the case of a light fire, Beech remains an important component within the early-successional stages of the maple, oak, birch complex, especially on drumlinoid topography. Because of the less severe disturbance, the successional trend will eventually lead to a climax forest of Sugar Maple, Yellow Birch and Beech.

Plants

The ground vegetation of the maple, oak, birch forest habitat belongs to the Bracken Fern

	association. This association is typically found in openings and in the less dense areas of the forest stand. It is tolerant of many topographic situations. The bracken fern almost always typifies a burned area, although evidence has shown it is also associated with windfall and logging disturbances to a lesser extent. Bracken Fern is the dominant species with Blueberry, Lambkill, and Bunchberry as sub-dominants.
Animals	The soil fauna is poor due to the poorly developed dry humus layer. There is however a fairly rich fauna in the tree crowns and along the forest margin. The Winter Moth that defoliates hardwood trees was studied in this habitat in the Bridgewater area. Birds include the Ovenbird, Rose-breasted Grosbeak, Red-eyed Vireo, and other small perching birds. White footed Mouse and Red Squirrel are typical mammals.
Special Features	1. Forest Succession after fires.
Distribution in Nova Scotia	The maple, oak, birch forest habitat is found in the granitic Atlantic Interior from west of Lake Rossignol to Halifax (unit 451) and in the bowl-shaped depression around the LaHave River in the south central portion of Nova Scotia (units 433 and 434). It also occurs scattered throughout much of the southern part of the Province (region 400).

ASSOCIATED TOPICS

T5 Granite, T14 Glacial Deposits, T31 to T35 Soils, T42 to T46 Vegetation and T49 Forest Birds.

ASSOCIATED HABITATS

H23 Spruce, Fir, Pine Forest

REFERENCES

Gimbarzevsky (1975)

H23 Spruce, Fir, Pine Forest

This major forest habitat is wide spread across the province. The Red Spruce, Balsam Fir, White Pine group is an early successional forest resulting from fire and cutting practices. One of the main features of this habitat is, in many cases, the presence of vertical zonation - a White Pine overstory and a spruce-fir understory.

Formation	The formation of this forest habitat occurs after fire or cutting on generally moist, well-drained sites. The general habit of this group is a few large White Pines, forming an upper, open canopy with the more shade tolerant Red Spruce and Balsam Fir forming a lower, dense secondary story. There is generally heavy balsam fir regeneration within the stand but Red Spruce is the more abundant species overall.
Physical Aspects	a) Bedrock: mainly sedimentary and metamorphic - shales, slates, siltstones, conglomerates; occasionally found on volcanics and granites. b) Soils: moderately deep, sandy loam to clay loam to gravelly clay loam glacial tills. Occasionally found on soils with bedrock near the surface. c) Relief: variable; flat lowlands and lower slopes to low rugged hills and upland flats. d) Drainage: drier, well-drained sites to poorly-drained flats.
Successional Sequence	The spruce, fir, pine habitat is an early to mid-succession forest usually found on moist sites. After fire or cutting spruce, fir, maple, and birch, plus relict White Pine, form an early successional forest. Young White Pine enters the stand on higher, dry hummocks. The hardwoods die from crowding, generally leaving a two-storied spruce, fir, pine stand.

Plants	The Bracken Fern plant association is usually found in the understory of the spruce, fir, pine habitat. Bracken fern, Blueberry, Lambkill and Bunchberry are the main components.
Animals	The accumulation of pine and spruce needles on the ground gives a poor humus layer and an impoverished soil fauna. Insects are mostly important in the canopy and are fed upon by canopy birds such as warblers. Red-back Salamander, Ring-neck Snake, and Red Squirrel are common. White-throated Sparrow, Nashville Warbler, Magnolia Warbler, Yellow-rumped Warbler and Kinglets are summer residents in this habitat.
Special Features	1. Large, old relict White Pine 2. Red Spruce considered sub-climax to climax species because of its shade tolerance and its reponse when released after severe suppression 3. IBP Recommended Ecological Reserves Shulie River - Red spruce forest Moose River - Red spruce forest Economy River - Old-growth red spruce forest Abraham Lake - Red spruce forest
Distribution in Nova Scotia	The spruce, fir, pine forest habitat is widespread throughout mainland Nova Scotia, in region 500 and more generally.

ASSOCIATED TOPICS

T34 Soils, Biological Environments, T45 Succession in Vegetation and T49 Forest Birds.

ASSOCIATED HABITATS

H24 Spruce, Fir, Pine-Maple, Birch Forest, H25 Spruce, Hemlock, Pine Forest.

REFERENCES

Gimbarzevsky (1975)

H24 Spruce, Fir, Pine-Maple, Birch Forest

The spruce, fir, pine-maple, birch forest is an early successional complex found on logged or burned, moist sites. Red Spruce, Balsam Fir, and White Pine dominate the upper story with the intolerant hardwoods, Red Maple and White Birch being present as minor components. The ground vegetation consists of the Bracken Fern plant association.

Formation	The Red Spruce, Balsam Fir, White Pine, Red Maple, White Birch forest habitat is the early successional stage following cutting or fire within the spruce, hemlock, pine climax forest habitat.
Physical Aspects	The spruce, fir, pine-maple, birch habitat type is typically found with the following environmental conditions: a) Bedrock: mainly occurring on hard igneous and metamorphic rock except in the Windsor Lowlands (unit 511) where it is present on shales and sandstones. b) Soils: shallow to moderately deep coarse (sometimes bouldery) sandy loams to clayey glacial tills. c) Relief: gently undulating lowlands to knoll-hummock complex to ridges. d) Drainage: dry to moist, lower seepage slopes.
Successional Sequence	The spruce, fir, pine-maple, birch habitat type follows cutting or fire in the predominantly coniferous spruce, hemlock, pine climax forest type. The major tree species in this habitat type are shade intolerant in their early growing stages and therefore require an open condition for initial establishment. The type may also originate from progressive long-term successional change in spruce, fir-maple habitats. Assuming seed sources are available, hemlock and tolerant hardwood species eventually find their way into most mature spruce, fir, pine-maple birch stands.

	Where soils underlying this forest type are infertile, successive fires through spruce, fir, pine-maple birch forests may lead to permanent changes in soil conditions and to the formation of more or less permanent barren land vegetation type.
Plants	The ground vegetation consists of the Bracken Fern plant association with Bracken Fern as the dominant species and with Blueberry, Sheep Laurel, and Bunchberry as common associates.
Animals	Generally poor soil and insect fauna. Small passerines and canopy birds such as warblers are important. Small mammals population has low diversity and low density.
Special Features	1. cutting and fire disturbance - invasion of intolerant hardwood 2. relict, large, old white pine, spruce and fir scattered throughout.
Distribution in Nova Scotia	The spruce, fir, pine-maple, birch forest habitat is predominantly found in the southwest part of the Atlantic Interior (region 400) and also, to a lesser degree, in the Windsor Lowlands (unit 511).

ASSOCIATED TOPICS

T4 Avalon and Meguma Zones, T45 Succession in Vegetation and T49 Forest Birds.

ASSOCIATED HABITATS

H30 Spruce, Fir, Maple Forest and H23 Spruce, Fir, Pine Forest.

REFERENCES

Gimbarzevsky (1975)

H25 Spruce, Hemlock, Pine Forest

The spruce, hemlock, pine forest is a near-climax or climax forest of much of Nova Scotia. The major species are Red Spruce, Eastern Hemlock and White Pine; the hemlock usually being the dominant species. This softwood group has been logged extensively for its valuable lumber.

Formation	The spruce, hemlock, pine forest habitat occurs on moist to relatively dry sites and represents a near-climax forest condition in such areas.
Physical Aspects	a) *Bedrock*: variable b) *Soils*: generally shallow, coarse, bouldery sandy loam to clay glacial tills. Along the Northumberland Shore district, this forest habitat can be found on lacustrine deposits. c) *Relief*: lowland flats to broad, flat, upland areas; lower slopes of low, rugged drumlinized hill complex. Also found on steeper slopes along water courses. d) *Drainage*: rapidly to well drained.
Successional Sequence	The removal of pine and fir by insect and porcupine damage from the mid-successional spruce, fir, pine forest habitat would probably pave the way for invasion by the tolerant Eastern Hemlock, thus culminating in a near-climax or climax spruce, hemlock, pine forest habitat on zonal sites.
Plants	The ground vegetation consists mainly of the humus-bryophyte association. In this group Schreber's Moss (*Pleurozium schreberi*), Broom Moss (*Dicranum* spp.), and liverwort (*Bazzania trilobata*) are co-dominants. This association is particularly dominant on hummocky sites. Any significant increase in the amount of light reaching the ground surface would allow for invasion by a number of herbaceous plant species.

Animals	Although the soil is acid, it supports a climax native soil fauna including slugs of the family Milomycidae. Small mammals include Red-backed Vole, Short-tailed Shrew, and Red Squirrel. Redback Salamander and Ringneck Snake may be common. The climax forest also includes old, dead standing trees that are utilized by woodpeckers, and provide cavities for hole-nesting birds and den sites for mammals.
Special Features	1. Old-growth Eastern Hemlock. Susceptibility of stand to windthrow. 2. IBP Recommended Ecological Reserves Melrose-Old-growth hemlock forest Oregon-Old-growth hemlock forest Burnaby Lake - Red spruce forest Shelburne River - Old-growth hemlock forest Sixth Lake - Hemlock-red spruce forest Broad River - Red spruce forest Silvery Lake - Old-growth hemlock forest Sporting Lake - Old-growth hemlock-pine forest Shady Brook - Red spruce-hemlock forest
Distribution in Nova Scotia	This forest habitat is found extensively throughout mainland Nova Scotia but particularly in district 530 and in the Bras d'Or Lake district (560) of Cape Breton Island.

ASSOCIATED TOPICS

T39 Mosses and Liverworts, T42 to T46 Vegetation, T50 Forest Birds and T55 Small Mammals.

ASSOCIATED HABITATS

H23 Spruce, Fir, Pine Forest.

REFERENCES

Keddy (1978)
Gimbarzevsky (1975)

H26 White Spruce Forest

Forest stands on abandoned farm fields and along coastline.

Because of its frequent early and heavy seed crops and as a result of its ability to colonize bare or nearly bare mineral soils, White Spruce is the major early successional forest type found colonizing abandoned agricultural lands in Nova Scotia.

Formation

In order for a site to be favourable for the establishment of White Spruce seedlings, the following conditions must be met:

a) a thin layer of humus or recent disturbance of the humus layer to expose bare mineral soil,
b) sufficient moisture to ensure early germination and growth,
c) sufficient sunlight (White Spruce becomes tolerant to shading once it becomes firmly established).

Physical Aspects

White Spruce stands are found growing in the following environmental conditions:

a) Bedrock: mainly sedimentary but occasionally on metamorphic and igneous bedrock.
b) Soils: relatively deep, loam to loamy clay glacial tills with a wide range of acidity conditions.
c) Relief: generally flat to undulating topography characteristic of agricultural lands.
d) Drainage: usually associated with well to imperfectly drained soils.

Successional Sequence

White Spruce forests are pioneer forests. Abandoned fields, characterized by Poverty Grass, Kentucky Bluegrass, Goldenrods, and various herbaceous annuals, gradually become speckled with small clumps of bushy White Spruce. In time these old field plant communities are overcome by dense uniform forests of White Spruce. The ecotones with other habitats are normally characterized by abrupt transitions. White spruce stands are subsequently invaded by Balsam Fir and tolerant hardwoods. Eventually these colonizing species give way to the regional climax forest of that particular area. White Spruce does not reproduce itself successfully under its own overstory for it is shade intolerant. The invasion of other tree species into the overmature White Spruce stand spells the end of this early successional forest habitat.

Plants

Old field herbaceous plants linger for some time under the developing pure White Spruce stands. Schreber's Moss and Broom Moss are generally the most important ground vegetation found in maturing stands of old field White Spruce. At maturity ground cover vegetation is characterized by Stair-step Moss (Hylocomium splendens) and the liverwort (Bazzania trilobata).

Animals

Small mammal diversity in mature white spruce forest is lower than in any other forest habitat in Nova Scotia, often only consisting of two species - Red Squirrel and Red-backed Vole. Young stands may provide habitat for Chipping Sparrows, while mature stands provide habitat for foliage gleaning birds such as kinglets and warblers. Various finches, eg. siskins and crossbills, feed on seed cones.

Special Features

White Spruce is often accompanied by alder, Larch and/or Balsam Fir as it colonizes abandoned fields. In the LaHave district of Nova Scotia, abandoned fields are quite often colonized by White Pine.

Distribution in Nova Scotia

The White Spruce forest habitat is distributed throughout the province in areas that, historically, have been agricultural areas especially the Carboniferous Lowlands (region 500). Many of the once active farms in central and northern portions of Nova Scotia are now characterized by White Spruce forests.

ASSOCIATED TOPICS

T42 to T46 Vegetation.

ASSOSCIATED HABITATS

H18 Oldfields, H28 Pine Forest and H35 Man-made Habitats.

REFERENCES

Gimbarzevsky (1975)

H27 Sugar Maple, Yellow Birch, Beech Forest

The hardwood climax forest of Nova Scotia.

Climax or near-climax hardwood forest consisting mainly of tolerant hardwoods occurring on higher ground. In North America, Nova Scotia represents the northeastern limit of distribution for this forest habitat type.

Associated Forest Cover Types include:

1) pure or mixed stands of Sugar Maple, Yellow Birch and Beech - well drained, lower to mid-slopes and hilltops.
2) White Birch, Yellow Birch - steep, mid to upper slopes; coarse rubbly soils.
3) Sugar Maple, Yellow Birch, Beech - Balsam Fir, White and Red Spruce, Eastern Hemlock, White Pine - mixedwood found on gravelly, unstable river fans and spurs; along stream ravines; and on previously logged slopes.

Formation	Assuming site conditions are favourable, the major factor in the establishment of the Sugar Maple, Yellow Birch, Beech forest is disturbance. In well drained upland sites the formation of this climax forest will be assured if no further natural or man-made disturbance takes place.
Physical Aspects	a) Bedrock: predominantly granite but occasionally quartzite, sedimentary and metamorphic rocks often overlain by sedimentary beds. b) Soils: sandy loam to loam textured glacial tills, moderately deep and generally rich in nutrients and water supply. c) Relief: ranging from the flat-topped uplands of the Cobequid Mountains to the rolling hills and uplands of Musquodoboit, Pictou, and Cape Breton. d) Drainage: rapidly to well drained with seepage slopes quite common.
Successional Sequence	Vegetation succession within the Sugar Maple, Yellow Birch, Beech complex is of a secondary nature, that is, successional changes brought

about by factors such as fire, cutting, insect infestation or landscape disturbance (colluvium activity).

Fire within this well drained, upland forest habitat would probably result in a successional intolerant hardwood stand consisting of Red Maple, White Birch, Red Oak, Aspen, and Beech, these species being able to develop from sucker growth. Eventually the shade tolerant hardwoods would intrude into the understory and gradually displace the shade intolerant species. Shade tolerant softwood species such as Red Spruce and Eastern Hemlock may also become locally established during this successional sequence.

Cutting practices within this forest habitat would produce a shift from a pure tolerant hardwood forest to a mixedwood stand dominated by the Spruce, Balsam Fir, Pine, White Birch, and Red Maple. Over time, this successional sequence will probably, if left undisturbed, revert to the original tolerant hardwood forest.

Insect infestation does not appear to affect this forest habitat as a whole. Insects, do, however, greatly influence individual species of this grouping. The Nectria-Cryptococcus association ("Beech scale") has brought about a dramatic decline in the number of beech in Nova Scotia. Birch dieback (causal agents unknown at present) as well as several minor pests, have also caused a reduction in the vigor and distribution of both White and Yellow Birch.

Rubble-strewn slopes (talus or colluvium slopes) support a White Birch - Yellow Birch forest type (possibly with minor components of softwoods) - a midsuccessional stage of this climax forest. As the slope stablizes, Sugar Maple and Beech will begin to occupy the site.

Plants

Ground Vegetation: Characteristic Species include: Rose Twisted Stalk, Broom Moss, Schreber's moss, Striped Maple, Starflower, Christmas Fern, Mountain Maple, Hazelnut, Shining Clubmoss, Bearberry and Wild Sarsasparilla.

Animals

This climax hardwood forest has rich soils that support a diverse soil fauna, including Philomycid slugs and minute snails such as *Planogyra astericus* and *Striatura exigua*. Rotting logs provide a good micro-habitat for beetles and other insects. Insects are also important in the canopy. Wood Frogs and Salamanders are common as are Warblers and Woodpeckers. This is an important small mammal habitat especially on talus slopes in Cape Breton where it supports 14 of the 20 small mammal species recorded in Nova Scotia.

Special Features

1. Beech scale
2. Birch dieback
3. Softwood component in ravine slopes
4. Stunted forests in Cobequid Hills often due to excessive wind exposure.
5. Rock vole, Gaspe shrew and Southern Bog Lemming on lower levels of old talus slopes in Cape Breton.

6. IBP Recommended Ecological Sites:
   - Fenwick
   - Clydesdale
   - Lake O'Law
   - Second Fork Brook
   - Grande Anse River
   - North Aspy River
   - Marion Bridge
   - Moses Lake
   - Cape Split

Distribution in Nova Scotia

The major occurrences of the Sugar Maple, Yellow Birch, Beech forest habitat are found in the Cobequid Hills, Pictou-Antigonish Highlands and North Bras d'Or Uplands of region 300; the slopes and ridges (district 420) and drumlins (430) of the Atlantic Interior; in higher sections of the Carboniferous Lowlands such as Hills and Valleys 580 and in the Annapolis Valley (unit 601). Minor occurrences are scattered throughout the interior of the province.

ASSOCIATED TOPICS

T34 Soils, Biological Environment, T42 to T46 Vegetation and T55 Small Mammals.

ASSOCIATED HABITATS

H20 Talus Slope, H25 Spruce, Hemlock, Pine Forest and H27 Sugar Maple, Yellow Birch, Beech Forest

REFERENCES

Eastern Ecological Research (1978)
Gimbarzevsky (1975)

H28 Pine Forest

The pine forest habitat, composed of White Pine, Red Pine and Jack Pine is scattered throughout Nova Scotia. Originating from fire, it usually forms pure stands or mixed stands with other fire successional species such as Red Maple, Red Oak, Trembling Aspen, or White Birch. Immature and mature stands do not permit a luxuriant ground vegetation growth either because of low light intensity and/or because a continuous shower of pine needles covers the ground surface.

Formation	The pines seed quickly after an intense fire, particularly on sandy, gravelly, or rocky, dry soils. This is especially true of Jack Pine which requires a great amount of heat to open its seed cones. A local seed source is, of course, necessary for the establishment of such a forest stand after the fire. This is usually provided by large relict pines, particularly White Pine, which have survived the devastation of the fire. Pure stands of White Pine frequently invade abandoned agricultural lands in the southern part of the province.
Physical Aspects	a) Bedrock: variable b) Soils: occasionally on moderately deep, fresh and well drained or coarse textured (sandy to bouldery) dry, soils with a very shallow glacial till or a sandy glacial outwash parent material. In many cases, this forest habitat is found on exposed bedrock with a minimal covering of humus. c) Relief: generally found on upland ridges and hills d) Drainage: rapidly to well drained; usually very dry sites.
Successional Sequence	Repeated burning or severe fire on dry sandy sites produces a Broom Crowberry or Bracken Fern association. If a seed source is readily available, the pines may in turn become established. Shade tolerant spruces will germinate and grow in the understory of the pine stands, and in the end a near-climax pine-spruce forest will develop. In

southwestern Nova Scotia White Pine will invade abandoned agricultural land.

Plants

When ground vegetation is present in the pine forest habitat, it is usually the dominant fire plant association found in the province - the Bracken Fern association. Even then, the species of this association - Bracken Fern, Blueberry, Lambkill, Bunchberry to name the dominants - are only found in forest openings where enough light penetrates to permit their growth.

Animals

The soil fauna is poor due to the accumulation of pine needles. Small mammal diversity and abundance is generally low, with the most common (and sometimes the only) species being Red Squirrels, Red-backed Voles and Cinerous Shrews. Birds include chickadees, warblers and juncos.

Special Features

1. Lack of ground vegetation
2. Relict White Pine stands - (oldest living organism in the province)

3. IBP Recommended Ecological Sites:
   Chignecto - Red Pine forest
   Black River Road - Jack Pine forest
   Hollahan Lake - Jack Pine forest
   Birch Lake - Old-growth White Pine forest

Distribution in Nova Scotia

This forest habitat is found throughout Nova Scotia but its best development occurs on the sandy soils of Shelburne, Queens and Annapolis counties (districts 410 and 450); on the sandy soils of district 550 in Cumberland County and in the fire barrens of northeastern Cape Breton Island (district 210).

ASSOCIATED TOPICS

T42 to T46 Vegetation.

ASSOCIATED HABITATS

H28 Pine Forest.

REFERENCES

H29 Spruce, Fir Forest

The spruce, fir forest habitat is a pure mid-successional coniferous forest. It regenerates on moist sites following logging of coniferous forests and occurs as natural stands in a successional sequence on wet depressional sites. Ground vegetation consists of the humus moss plant association, where Schreber's Moss and Broom Moss dominate.

Formation	The spruce, fir forest habitat is a later successional stage of the Black Spruce, Larch forest habitat. Generally, it occupies swales and poorly drained depressional areas.
Physical Aspects	Spruce, fir forest stands occur in areas exhibiting the following physical conditions: a) Bedrock: mainly hard metamorphic, igneous, and volcanic rock, sometimes overlain by sedimentary deposits. b) Soils: mostly shallow sandy loam to loamy glacial tills with scattered deposits of marine and estuarine clays and clay loams developed from basalt. c) Relief: predominantly found on upland flats and lower slopes and valley bottoms but also along the coastline of the Bay of Fundy. d) Drainage: usually imperfectly to poorly drained.
Successional Sequence	As the site conditions of the Black Spruce, Larch forest habitat progress from a very wet to a moist condition, the Black Spruce component increases at the expense of the shade-intolerant Larch. Over time, with the formation of a drier, hummocky surface, and improved drainage in general, White Spruce, Balsam Fir, and occasionally Red Spruce will invade the site to produce a spruce, fir forest habitat. On drier sites where the stand has resulted from cutting of a former forest White Pine and tolerant hardwoods may later invade this habitat type.

Plants

The humus-moss plant association is found under the closed canopy of this forest habitat. Schreber's Moss, Broom Moss and liverwort (*Bazzania trilobata*) dominate this community. In natural openings or thinnings, a Wood Fern/Wood Sorrel plant association becomes prevalent. Again Schreber's Moss is dominant along with Wood Fern and Wood Sorrel.

Animals

The acidic humus from spruce and fir needles supports a poor soil fauna, and the lack of diversity and deciduous trees is also a deterrent for other animal groups. Red Squirrel, Red-backed Vole and Short-tailed Shrew may be common. Birds include Spruce Grouse, Yellow-bellied Flycatcher, Dark-eyed Junco and Hermit Thrush.

Distribution in Nova Scotia

The spruce, fir forest habitat is found, in depressions throughout southeastern Nova Scotia, on the upland flats, lower slopes, and valley bottoms of the Cobequid Hills, the North Bras d'Or Uplands and Mabou Highlands (region 300) and the Pictou Antigonish Highlands. This forest habitat also occupies the coastline and immediate interior of the Fundy Coast and North Mountain (region 700). On the Cape Breton Plateau (region 100), a high, exposed oval tableland, this forest is present in a stunted, windswept form.

ASSOCIATED TOPICS

T34 Soils, Biological Environments, T39 and T40 Mosses and Ferns and T42 to T46 Vegetation.

ASSOCIATED HABITATS

H33 Black Spruce, Larch Forest and H23 Spruce, Fir, Pine Forest.

REFERENCES

Eastern Ecological Research (1978)
Gimbarzevsky (1975)

H30 Spruce, Fir-Maple Forest

An early successional stage leading eventually to the climax spruce, hemlock, pine forest, this forest habitat is found on moist to wet sites and is dominated by Black Spruce, Balsam Fir, and Red Maple, with the Cinnamon Fern plant association typically the dominant ground cover. Occasional minor components of this habitat are Red Spruce, Eastern Hemlock, pines, and Larch; the first three occurring on the drier sites and the latter occurring on the wettest sites.

Formation This habitat type is found primarily in swampy areas where the water table varies considerably throughout the year. In addition as the wet bog edges become somewhat drier, the Black Spruce, Larch forest is gradually replaced by the spruce, fir-maple forest group. Unlike Larch, which prefers a very wet open site, Balsam Fir and Red Maple are better suited to a moist, hummocky site. Fir is quite shade tolerant and can reproduce under a closed canopy of spruce and Larch.

Physical Aspects This habitat type is usually found under the following physical conditions:

a) Bedrock: mainly occurring on hard igneous and metamorphic rock except in the Windsor-Truro lowland where it is present on shales and sandstones.
b) Soils: shallow to moderately deep, moderately coarse to moderately fine glacial tills.
c) Relief: gently undulating lowlands and depressions in knoll-hummock complexes between ridges.
d) Drainage: generally imperfectly to poorly drained moist to wet sites, but showing a definite preference for more mesic sites.

Successional Sequence The spruce, fir, maple forest habitat is the subsequent, drier relative of the wet, periodically inundated spruce, Larch, maple forest habitat. Once the site becomes drier due to the cessation of flooding and/or the organic buildup of hummocky ground, Balsam Fir invades the understory, eventually crowding out the Larch. This slightly drier habitat will then support a spruce, fir, maple stand.

Plants The typical smaller plant community found in the spruce, fir (larch) maple habitat type is the Cinnamon Fern association. Cinnamon Fern characterizes this complex community type. A wider variety of herbaceous and woody plants and shrubs are found within the community, some in wet pockets and others on hummocks.

Animals Small mammal diversity in this habitat is low to moderate, with the White-footed Mouse, Red-backed Vole, Cinerous and Short-tailed Shrews, and Red Squirrel being the characteristic species towards the end of the successional sequence. Warblers, chickadees, junco, thrushes and White throated Sparrows are common in this habitat type.

Special Features Two rare plants in Nova Scotia are known from this habitat. Dwarf Chain Fern in southwestern Nova Scotia and Marsh Marigold from Northern Cape Breton.

Distribution in Nova Scotia As with the spruce, fir, pine-maple, birch habitat, the spruce, fir, maple group can be found mainly in the southwest portion of the Atlantic Interior (region 400) as well as the Windsor Lowlands (unit 511).

ASSOCIATED TOPICS

T40 Ferns, T42 to T47 Vegetation.

ASSOCIATED HABITATS

H33 Black Spruce, Larch Forest, H24 Spruce, Fir, Pine - Maple, Birch Forest.

REFERENCES

Gimbarzevsky (1975)

H31 Balsam Fir Forest

Balsam Fir habitat is the climax forest of the boreal forest region in Nova Scotia.

The Balsam Fir forest habitat is an ecosystem with very little species diversity. Eighty percent of the habitat is dominated by mature, relatively dense Balsam Fir. Fauna and ground vegetation are characterized by a very limited number of species.

Formation	The boreal forest region in Nova Scotia is confined to northern Cape Breton Island. This high, flat, plateau is characterized by a boreal forest made up almost exclusively of Balsam Fir, with an admixture of White and Black Spruce, Mountain Ash and White Birch. The influence of altitude and wind limit tree height and growth dramatically.
Physical Aspects	a) Bedrock: granite, gneiss, and schist. b) Soils: mostly stony, deep and/or compacted glacial till with minor occurrences of exposed bedrock - patchy glacial till. Organic soils are scattered throughout. c) Relief: occurring at elevations of 1,000 - 1,700 feet (300 - 500m) above sea level. The typical topography for this forest habitat ranges from a flat terrain to hilly complexes. d) Drainage: This forest type occurs on the complete spectrum of soil drainage classes from rapidly to poorly drained.
Successional Sequence	The early successional forest following disturbances in this climax boreal forest habitat is often dominated by immature White Birch. As the birch grows and provides more ground shading, Balsam Fir seedlings become established in the understory. The mid-successional stage of the Balsam Fir forest habitat is a mixedwood stand of Balsam Fir and White Birch. Finally, the short-lived White Birch begin to be crowded out as the climax Balsam Fir stand matures.

Plants This moist, dense coniferous forest habitat favours a ground cover predominantly composed of mosses and liverworts - Schreber's Moss, Broom Moss, Stair-step Moss, and the liverwort (*Bazzania trilobata*). As openings occur in the canopy of the forest stand herbaceous species such as the Wood Fern, Wild Lily-of-valley, Twinflower, Wood-sorrel, Wild Sarsaparilla, Clintonia, Goldthread, Bunchberry, and Wood Aster gain prominence, as well as the mosses.

Animals As mentioned above the fauna of the Balsam Fir forest habitat is poor due to the sterile humus layer and lack of plant diversity. Small mammal diversity is low, with Red-backed Vole, Deermouse, Red Squirrel and Cinerous Shrew being the characteristic species.

Special Features

1. Stunted growth of Balsam Fir due to wind exposure;
2. Presence of old relict White Spruce scattered throughout this forest habitat is unexplainable since the forest here has been repeatedly devastated by insect outbreak and windthrow.
3. Dogberry is generally restricted to this habitat.
4. I.B.P. Recommended ecological site - Sunday Lake

Distribution in Nova Scotia The Cape Breton Highlands (district 210) is the only area where the climax Balsam Fir forest habitat is found.

ASSOCIATED TOPICS

T20 Climate, T35 Hardpans, T39 Mosses and T42 to T46 Vegetation.

ASSOCIATED HABITATS

H17 Barren, H29 Fir (Spruce, White Birch) Forest and H33 Balsam Fir, Black Spruce, Larch Forest.

REFERENCES

Eastern Ecological Research (1978)

H32 White Spruce, Fir-Maple, Birch (Coastal) Forest

The White Spruce, fir-maple, birch forest habitat is confined to the fog-bound Atlantic coast of Nova Scotia and coastal bluffs and headlands and around the Bay of Fundy. Trees exhibit stunting and "krummholz" due to severe wind exposure and salt spray. Under a dense tree canopy the Schreber's Moss plant association is dominant whereas the Wood Fern-Wood Sorrel plant association becomes of primary importance where openings or thinning of the canopy occur. Red Maple and White Birch enter the habitat where cutting or fire has taken place.

Formation	The White Spruce, Balsam Fir, Red Maple, White Birch forest is the climax forest of the province's rocky and exposed southwestern to northeastern coastline.
Physical Aspects	a) Bedrock: variable; but mainly granite and quartzite. b) Soils: shallow sandy loam glacial tills alternating with exposed bedrock. c) Relief: coastal bluffs and headlands. d) Drainage: generally imperfectly to well drained.
Successional Sequence	The seacoast causes a very dynamic and often changing habitat. White Spruce can colonize this habitat because of its tolerance to salt spray. Balsam Fir is found further inland behind the protection of the White Spruce. Red Maple and White Birch may be found inland with the fir and spruce, because of fire or cutting activities.
Plants	The ground cover under a closed canopy of the White Spruce, fir - maple, birch forest habitat is characterized by the Schreber's Moss association. Here Schreber's Moss and Broom Moss totally dominate the vegetation. When openings or thinnings in the canopy occur a more herbaceous plant association occupies the ground. This Wood Fern/Wood Sorrel association consists of the dominant Wood Fern, Wood Sorrel, and Schreber's Moss along with the sub-dominants; Broom Moss, Wild

Lily-of-the-valley, Star-flower, Goldthread, Clintonia, Bunchberry and Wood Aster.

Animals

Soil and other animals communities are poorly developed. Red Squirrel may be common. On some islands the trees are used as nesting sites and roosts for seabirds, such as Cormorants, Common Eiders and Herons. The dropping from these birds speeds the demise of the trees that are living in a very exposed habitat.

Special Features

1. "Krummholz" forest-wind-swept trees with branches growing mostly on lee side.
2. White Spruce most salt-tolerant of native tree species.

Distribution in Nova Scotia

The White Spruce, fir-maple, birch forest habitat is found along the southwestern coast from Digby to the northeastern coast of Cape Breton Island (region 800). Along the eastern coast from Halifax north, Black Spruce assumes as much importance as white spruce in the forest stand.

In coastal headlands of Eastern Cape Breton (districts 210, 540 and 550) the little alpine form of Balsam Fir (*Abies balsamea* var. *phanerolepis*) grows right next to the sea on cliffs and barrens in "krummholz" association with White Spruce.

Betula cordifolia is the dominant Birch species in this Eastern Cape Breton coastal area. *B. papyrifera* and *B. alleghaniensis* do occur but not with such frequency or population density.

ASSOCIATED TOPICS

T20 Climate and T42 to T46 Vegetation.

ASSOCIATED HABITATS

H17 Barren.

REFERENCES

Science Section Staff, N.S. Museum

H33 Black Spruce, Larch Forest

This ecosystem is found along bog or swamp edges and is characterized by generally stunted open, Black Spruce-Larch forests with sedge-moss (Carex-Sphagnum) as the dominant ground cover.

Formation	The Black Spruce, Larch, forest habitat is the dominant forest cover of wet, depressional areas and edges of bogs and swamps.
Physical Aspects	a) Bedrock: generally hard igneous and metamorphic. b) Soils: organics and moderately coarse to fine glacial tills. c) Relief: flat to depressional areas. d) Drainage: poorly to very poorly drained sites.
Successional Sequence	The Black Spruce, Larch forest is the first forest type in the forest succession on moist to wet sites, typically found at the edges of bogs and in depressional areas. Initially the area is in a non-forested state, either that of a bog or open water. Over time as the site becomes built up with organic matter and rises above the water table, the Black Spruce and Larch invade.
Plants	The sedge-moss plant association dominates the ground vegetation in this wet forest habitat. Carex stricta and Sphagnum fallax dominate the association. On wet to moist drainage classes, Cinnamon Fern may become important along with the Sphagnum species. Other common plants are Labrador Tea, Lambkill and Rhodora.
Animals	The soil fauna is poor. Because of poor drainage the small mammal species present are virtually always temporary visitors from adjacent habitats, rather than residents. Birds include Canada Warbler, Common Yellowthroat, Olive-sided Flycatcher, Blackbacked Three-toed Woodpecker, Ruby-crowned Kinglet, White-throated Sparrow, and Black and White Warbler.

Special Features	1. stunted or retarded growth of spruce and larch due to excessive moisture from nearby bogs and swamps. 2. extremely slow-growing forest - trees may only be a couple of meters high but may be over one hundred years old.
Distribution in Nova Scotia	Although usually occupying small areas the Black Spruce, Larch forest habitat is generally found throughout mainland Nova Scotia and Cape Breton Island.

ASSOCIATED TOPICS

T39 Mosses and T42 to T46 Vegetation.

ASSOCIATED HABITATS

H15 Bogs, H35 Swamp.

REFERENCES

Science Section Staff, N.S. Museum (1978)

H34 Sugar Maple, Elm (Flood Plain) Forest

The climax forest of floodplains.

Valley floors of the larger river systems with rich intervale soils support a great diversity of vegetation. Climax forest cover consists of Sugar Maple, and Elm, with minor components of birches, Balsam Poplar (limited mainly to northern Cape Breton), White Spruce, Willow, Red Maple and American Ash.

Formation

The lower trunk of a large river may not be able to handle the waters brought to it by the upper branches, and may deposit sediment transported by flood waters on adjacent lands to form a floodplain. The level of the floodplain gradually builds up to a point where terrestrial vegetation can gain a foothold. Under these conditions the Sugar Maple-American Elm forest habitat becomes established on stable, mature to old-age river floodplains.

Physical Aspects

a) Bedrock: variable
b) Soils: sandy to gravelly alluvium (fluvial and/or fluvioglacial.)
c) Relief: flat to very gently undulating, slow-moving sections of rivers.
d) Drainage: well to excessively drained.

Successional Sequence

The successional sequence within the Sugar Maple-American Elm forest habitat is probably the result of two factors: the natural life cycle of the river and disturbance by man. As the river matures from a boulder plain to an alluvial flood plain, a corresponding change in moisture regimes, and thus in vegetation, occurs. The early successional mesic site generally supports a forest composed of admixtures of Balsam Poplar, White Spruce, White Birch, and Willow. As the floodplain stablizes and matures, a climax forest habitat of Sugar Maple and Elm with a minor component of Ash represents the change from a hydric to a xeric condition.

Plants

Much of the ground vegetation of river floodplains belongs to the Alleghenian floral element. The greatest concentration of this element in Nova Scotia occurs in the Sugar Maple, Yellow Birch, Beech and Sugar Maple-Elm forest habitat of the Cobequid Mountains. Also, pockets of this flora are scattered through the central and northern counties of the mainland (e.g. Kemptown and South Maitland) and in sheltered locations on Cape Breton Island (eg. Glencoe).

The floodplain flora is dominated by the shrubs - Speckled Alder, Hazelnut, the hawthorns and Hop-Hornbeam; and by the herbs - Bloodroot, Enchanter's Nightshade, Dog's-tooth Violet, Ostrich Fern, Sensitive Fern, Avens, Cow-parsnip, Rough Goldenrod, Tall White Aster, Wood Goldenrod, Dutchman's Breeches, Spring Beauty, Hairy Sweet Cicely, Yellow Violet, Nodding Trillium, Feverwort and Blue Cohosh.

Animals

The rich soil of the floodplain, replenished with silt by frequent floods with the humus developed from the leaves of deciduous trees provides the basis for soil fauna. However, the soil fauna may be inhibited on sites where flooding is too frequent. During the summer more active animals invade the habitat from adjacent habitats. Where flooding is infrequent, small mammal diversity is moderate to high, and population levels can be very high. Toads and salamanders and the Maritime Garter Snake are common. The crowns of the trees support rich insect and bird life. Warblers, vireos, flycatchers, Common Grackle, Veery and Yellow-bellied Sapsucker are common in these woods.

Special Features

1. Dutch Elm Disease
2. Rare floodplain plants
3. Early spring-flowering plants
4. Most northern distribution of Alleghenian floral element.

Distribution in Nova Scotia

The Sugar Maple-Elm forest habitat is confined to the larger river floodplains of the central and northern counties of the mainland and Cape Breton Island throughout region 500 and has been heavily limited by cultivation of the fertile alluvial soils which underlie it and by grazing.

ASSOCIATED TOPICS

T15 to T17 Colonization, T29 and T30 Surface Waters and T42 to T47 Vegetation.

ASSOCIATED HABITATS

H13 Slow-moving Stream and H27 Sugar Maple, Yellow Birch, Beech Forest.

REFERENCES

Keddy (1979)
Roland and Smith (1969)

MAN-MADE HABITATS

H35 Man-made Habitats

In Nova Scotia, as in many other parts of the world, the natural environment as we know it today includes, to varying degrees, the influence of man as an agent of change. The Natural History of Nova Scotia attempts to describe the diversity of nature without the influence of man, although this influence is often very apparent in the landscape. The natural forest vegetation has been replaced in many areas by agricultural crops, pastures and buildings. Most of Nova Scotia's forests have been cut at some time and the natural succession is often influenced by forestry practices. Other man-made influences such as acid precipitation and other pollutants may have a widespread, though initially less visible, impact on the natural environment.

The general characters of man-made habitats are as follows:

1. They are often unstable and if not maintained by human activity would be the first stage of succession towards a naturally occurring vegetation and habitat type. In very disturbed areas this may be a very long process.
2. The conditions that occur are special and can be tolerated by relatively few species, which may however be present in large numbers.
3. The habitat may be occupied primarily by introduced species as opposed to native species. These may be cultivated species, escapes or species that are normally found only in association with human activity (anthropophilic species).
4. Primary production may range from very low in areas with low nutrient, light and moisture levels to very high in areas with artificial nutrient enrichment and adequate light and moisture levels.
5. The site may be degraded in an ecological sense by continued disturbance and the removal of nutrients through erosion and harvesting of crops.

The following is a list of man-made habitats that occur in Nova Scotia. Only the special characteristics of the habitats are given and the reader is refered to the most appropriate link with naturally occurring habitat types where appropriate.

AQUATIC HABITATS

Marine Docks and Pounds

The quality of the sea water may be affected by chemical or thermal pollution or concentrations of organic waste and this may limit or enhance the occurrence of some species. The normal marine plankton, nekton and benthos communities prevail in the absence of these pollutants. On wharves, the appropriate pattern of intertidal zonation will be seen well defined on vertical structures. Submerged structures will have the same benthic community as rock bottoms.

Water Conduits

The sea water intakes and outfalls of thermal and tidal electricity generating stations, industrial plants and sewage treatment plants will be colonized by benthic epifauna. As there is no light, plant life does not exist and the animal species assemblage is mainly limited to particulate feeding types such as Blue Mussels and Barnacles. These species may become sufficiently abundant to reduce water flows and they need to be controlled by chlorination and other techniques.

In freshwater fouling by organisms is not regularly a problem. Crustaceans and oligochaete worms such as *Tubifex* may occur.

Reservoirs and Canals

These are basically freshwater lake and stream habitats but subject to unnatural seasonal water level changes. The ecologically most significant change is hypolimnetic withdrawal or the removal of bottom water. The shallow water, limnetic zone flora and fauna is often poorly developed but these habitats may be biologically active. Good examples are the dam and canal systems of Gaspereau River (units 422 and 451) and Wreck Cove hydroelectric systems (district 210).

Ponds and Drainage Ditches

These are small bodies of water often with marked seasonal variations in water level, having most water in the spring (vernal ponds). They may be subjected to nutrient enrichment, concentrations of road salt and herbicides and the margins are often trampled by cattle. These are basically pond habitats, subject to vegetation succession and progressive infilling. Roadside ponds created during highway construction often support large populations of amphibians because of the lack of aquatic predators (fish) and the warm temperatures, and have helped to disperse some species to areas where they were not previously found. Due to isolation and disturbance aquatic invertebrate fauna may be poor. At one time there were many ponds established for sawmills, but few now remain. There are, however, over 400 farm ponds and 75 impoundments on tidal marshes managed by Ducks Unlimited that provide important wildlife habitat. Some ponds are artificially stocked with fish.

TERRESTRIAL HABITATS

Fields under Cultivation

The objective of agriculture is to control the nutrient, moisture and light resources of land to produce a desired crop species. This process involves cultivation of the land, use of fertilizers, seeding, application of herbicides to control competitive plant species (weeds), application of fungicides and pesticides and harvesting. Without adequate care the site may be degraded through erosion and nutrient loss and adjacent sites may be altered through herbicide and pesticide application. The monoculture crop species is usually accompanied by other hardy plant species, usually introductions, and the habitat may be used by various species of wildlife as a source of food and shelter.

When abandoned, the successional process to oldfield and forest begins.

Orchard

The characteristics of this habitat are similar to those of fields under cultivation, but the species in the monoculture are trees. The ground flora is generally composed of grasses and introduced meadow plants. Domestic animals may be grazed amongst the trees and there is commonly maintenance of beehives. This habitat type is particularly common in the Annapolis Valley (unit 601).

Pasture

Pasture is maintained grassland habitat used as a feeding area for cattle, horses, sheep and goats. Dry upland or wet lowland pasture will be used for the most suitable animals. This habitat needs to be maintained through grazing or removal of bushes, otherwise it will rapidly revert to forest through the oldfield succession. Apart from the effects of a concentration of grazing animals, which include fertilization and compaction of the soil through trampling, the pasture habitat may be in relatively natural state and utilized by native plant and animal species eg. American robin, as well as the introduced species.

Parks, Gardens and Greenhouses	These are examples of sites with intensive human management and control of conditions. The conditions of shade, fertilization and moisture are used to maintain growths of non-native plant species. However, such habitats are susceptible to unwanted plants (weeds) and animal species which need to be actively controlled. Furthermore, garden slugs, earwigs, sowbugs and other invertebrates are all introductions which thrive well in the conditions made available in this habitat. Control of pest species is often through the use of herbicides, fungicides and pesticides. Colonization by some plants such as lichens may be limited by air pollution in city centres.
Buildings and Furnishings	The habitats provided within domestic and industrial buildings provide food and shelter for a variety of fungi, arthropods, mammals and birds. These species mainly utilize stored food and organic materials in clothes and furnishings. Because of low light levels in buildings there is normally no primary production. The animal species include those with long human associations such as the house mouse and silverfish, as well as species that are parasitic on humans or domestic animals, eg. fleas and bed bugs. These species may be sufficiently abundant that they cause economic loss or become health hazards and need to be controlled as pests.
Disturbed Land (gravel pits, transportation routes, waste grounds)	The active removal or disturbance of the soil produces conditions intolerable for the majority of plant and animal species. The absence of soil results in dry, nutrient poor conditions; the absence of vegetation, particularly trees, allows for extremes of temperatures and exposure to light and wind. Some hardy plant species are able to colonize this hostile environment, eg. Coltsfoot and Plantain. If the site is abandoned a slow succession will eventually provide a more diverse and dense cover of mainly introduced plant species. Eventually shade intolerant trees such as Choke Cherry and Wire Birch will become established on the site.

Quarry

Active quarries in which the rock face is continually being blasted and removed provide a very sterile habitat. In formations where the rocks are fossiliferous, however, there is a constant supply of raw material exposed for the fossil collector.

Where a quarry is abandoned it continues as a cliff habitat eventually becoming colonized by plants and animals according to the conditions of height, rock type and aspect (north-facing slopes tend to be cool and moist, south-facing slopes dry and hot). Progressive weathering and rock fall will result in the accumulation of a talus slope.

Mines and Tunnels

Active mines and other tunnel structures often have carefully regulated conditions that do not favour colonization by fungi and animals. The absence of light prohibits the growth of green plants. Following abandonment the tunnel will change to a cave habitat. Percolating water and decomposing timbers will result in the formation of a thin soil. This soil will become colonized by fungi and soil animals, particularly where there is enrichment with nutrients and organic material from the droppings and carcasses of animals using the tunnel as a hibernaculum. Old mines deep or long enough to have a stable temperature and humidity regime throughout the year are potential hibernacula for bats (*Myotis* spp.).

ASSOCIATED HABITATS

H1 Benthic, H2 Open Water, H3 Rocky Shore, H10 Freshwater Pond, H11 Freshwater Lake, H12 and H13 Streams, H18 Oldfield, H19 Cliff, H20 Talus Slope, H21 Cave

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Volume

2

NATURAL HISTORY
OF
NOVA SCOTIA

VOLUME TWO

THEME REGIONS

Parks and Recreation Division
Department of Lands and Forests

and

Nova Scotia Museum
Department of Education

Natural History of Nova Scotia

Volume Two
Theme Regions

Prepared for:

Parks and Recreation Division
Department of Lands and Forests

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Maritime Resource Management Service Inc.
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Theme Regions: Geographical Classification System

INTRODUCTION

In the Topic section of Volume I reference is made to the relationship between geology, surficial materials, landforms, topography, hydrology, plant communities, wildlife and other aspects of the natural environment. In volume II these relationships are used as the basis of a geographical classification system of Regions and sub-Regions (districts and units).

It is intended for the reader to be able to identify these regions, districts and units in the field, to know when a boundary (or transition zone) is being crossed and to identify the distinctive environmental relationships within each one.

In order to aid in the understanding of how these geographical entities have been derived a hierarchical system of description has been developed. This approach closely follows the Biophysical Land Classification System as first proposed by Lacate.

CLASSIFICATION SYSTEM

The three levels in the hierarchy are as follows:

1. Regions,
2. Districts,
3. Units

The nine Theme Regions in Nova Scotia are divided in turn into 31 Districts which are again subdivided into 65 Units.

In the Biophysical Land Classification, Land Regions are defined on the basis of, "regional climate as expressed through regional vegetation". The classification adopted here recognizes six regional climates in Nova Scotia but further divides two of these climatic types on the basis of regional geology to create nine Theme Regions, as shown on the next page.

At the second level different Districts within a given Region are defined by, "a distinctive landscape pattern". This pattern may be a reflection of the geology, surficial materials, soils, hydrology, relief or vegetation. In each case one dominant element is selected as the defining characteristic; other elements are usually closely related. Definition of Districts corresponds closely to the definition of land districts adopted in Biophysical Land Classification.

Theme Regions

Theme Region Number	Name	Climate*	Regional Vegetation	Regional Geology**
100	Plateau Taiga	1	Taiga-Spruce	1
200	Highlands	2	Fir	1
300	Avalon Uplands	3	Maple-Birch-Fir	2
400	Atlantic Interior	4	Spruce(Maple)-Hemlock Pine	3
500	Carboniferous Lowlands	4	Spruce(Maple)-Hemlock Pine	4
600	Triassic Lowlands	4	Spruce-Hemlock-Pine	5
700	Fundy Coast	5	Transition	6
800	Atlantic Coast	6	Spruce-Barrens	3
900	Sable Island	6	Marram Grass	7

*Climatic Regions

1 Exposed Plateau - high winds
2 Highlands - short summers
3 Uplands - high precipitation
4 Interior - warm summers
5 Fundy - moderated interior
6 Atlantic Coast - mild winters, high winds

**Geological Regions

1 Ancient, high plateau
2 Resistant fault blocks
3 Meguma Group and granitic intrusions
4 Carboniferous sediments
5 Triassic sandstones
6 Basalt and fault blocks
7 Mobile sand

Units, the smallest geographical divisions identified here, are generally fairly homogenous areas within Districts. Landscapes may vary within them but reflect a recurring pattern of landform, soils or vegetation. In some instances various parts of a Unit may be geographically separated from each other. In these cases suffixes are used to indicate their relationship to one another.

The following example is presented as an aid to interpretation of the geographical divisions:

313 (a)	This area is known as the Creignish Hills on the north west shore of Bras d'Or Lake in Cape Breton Island.
Theme Region 300	The first number, 3, refers to the Avalon Uplands theme region (300). These upland areas experience more severe winters, with greater amounts of precipitation and shorter growing seasons than the surrounding lowlands. Climatic conditions are not as harsh as in Cape Breton Highlands. This climate is reflected in the dominant hardwood vegetation characterized by a Sugar Maple, Yellow Birch, Fir Association.
District 310	The second number, 1, refers to the distinctive geology and landforms found in District 310. This District emcompases six of the ten plateaux which comprise Theme Region 300. These six plateaux are all sharply defined with level plateau surfaces at elevations between 650 and 1,000 feet (200 and 300 m). Margins of the plateau generally fall abruptly 500 feet (150 m) or more, with little dissection by stream valleys.
Unit 313	The third number differentiates the three hill masses on the north shore of Bras d'Or Lake from two larger Units in District 310, located on the mainland, and another on Cape Breton Island. Differences in geology, glacial history and soils combine to define the unique combination of features found in unit 313 from the somewhat similar features found in units 311, 312 and 314.

313 (a) Three hill masses; Creignish Hills, North Mountain and Boisdale Hills comprise unit 313. The hills are separated by the lowland fringes of the Bras d'Or Lake and are identified by the suffixes a,b and c.

NOTE: In some cases Districts are not subdivided into Units. In these cases the reference number ends with a zero eg. Cape Breton Highlands fir forest, 210, but may include information normally found at the Unit level.

BOUNDARIES:

i) General - Rock types found in theme Region 300 are more resistant than the surrounding rocks. As a result isolated and well-defined hill masses have been formed by differential erosion of the soft and hard rocks. These hill masses are sufficiently elevated above the surrounding landscape to create distinctive climates. The more severe climate of the hills has in turn led to the dominance of forest types quite different from the surrounding lowlands. Bedrock geology is also reflected in the generally thin soils over bedrock.

In the case of Theme Region 300 the distinctive regional climate is created by the elevation, which in turn has evolved from the differences in bedrock geology which have also determined the nature of surficial materials. Climatic boundaries are therefore sharply defined and coincide with topography, bedrock geology and soils boundaries.

ii) Theme Regions: - Among the nine Theme Regions only two sets of boundaries are ill-defined. Both are instances in which the regional climate is not determined by topographic and geological breaks in the landscape. All other boundaries of theme regions are easily identified by abrupt topographic breaks which are in all cases attributable to the underlying geological structure.

The two ill-defined boundaries are:
a) Atlantic Coast: Wind and salt spray prevent normal growth of trees along the exposed Atlantic coast. Headlands and islands are frequently barren of trees. Inland, spruce is the most hardy tree and may dominate the forest for up to 5 miles (3 km) from the coast. As conditions become kinder inland, maple and birch begin to appear; other species grow according to local conditions. The inland boundary of the coastal forest varies considerably and cuts across all geological and topographic features.
b) Highlands Taiga: Extreme exposure to winds stunts tree growth on the highest parts of the Cape Breton Highlands. While a large area is identified as taiga in the vicinity of the National Park, a variety of smaller areas of taiga occur in exposed locations to the north and south. Occurence of wind dominated taiga does not reliably correlate with topographic conditions.

iii) Districts: - Various dominant environmental criteria are used to define Districts. Each District has one defining characteristic which is usually an element of the physical environment, most often bedrock geology. Surficial materials, landforms and vegetation are also used in some circumstances. Frequently the occurrence of the dominant factor is closely linked with other environmental conditions. For example, within the Carboniferous Lowlands (Theme Region 500), a very distinct District is defined by Kingsville soils. These soils are derived from the Scotch Village Formation in which flat-lying strata give a very level surface. The formation produces heavy clay soils which have very poor surface and slow internal drainage. As a result large organic deposits have accumulated. The Scotch Village Formation occurs over a wider area than District 540 while the peat bogs cover a smaller area than the District. The District boundary is in this case therefore a compromise between the two.

The selection of the dominant characteristic on which District definition depends is a matter of judgement.

iv) Units: - Within a Unit most of the major environmental factors do not vary. A significant change in any one of these factors in fact differentiates one Unit from another. This does not imply that Units are homogenous, but that the environmental conditions create recurring patterns. For example, within the Atlantic Coast (Theme Region 800) a District with a dominance of abundant coastal sediment (District 830) is recognized. In turn four Units are recognized as follows:

831 long, shallow estuaries with extensive salt marshes,
832 eroding drumlins, islands and isolated sand beaches,
833 shallow, large estuaries, salt marshes, sand beaches,
834 coastal islands.

It can be seen that the Units have many similarities but at least one of the major factors is different in each. Within the Unit a repetitive, recognizable sequence of these major environmental factors occurs. Boundary conditions are usually well defined as, for example, between Units 823 and 824: Coastal islands occur east of Owls Head and sandy beaches occur west of Owls Head. Estuaries to the west are characterized by salt marshes while those to the east of Snip Harbour are generally smaller and without significant salt marshes.

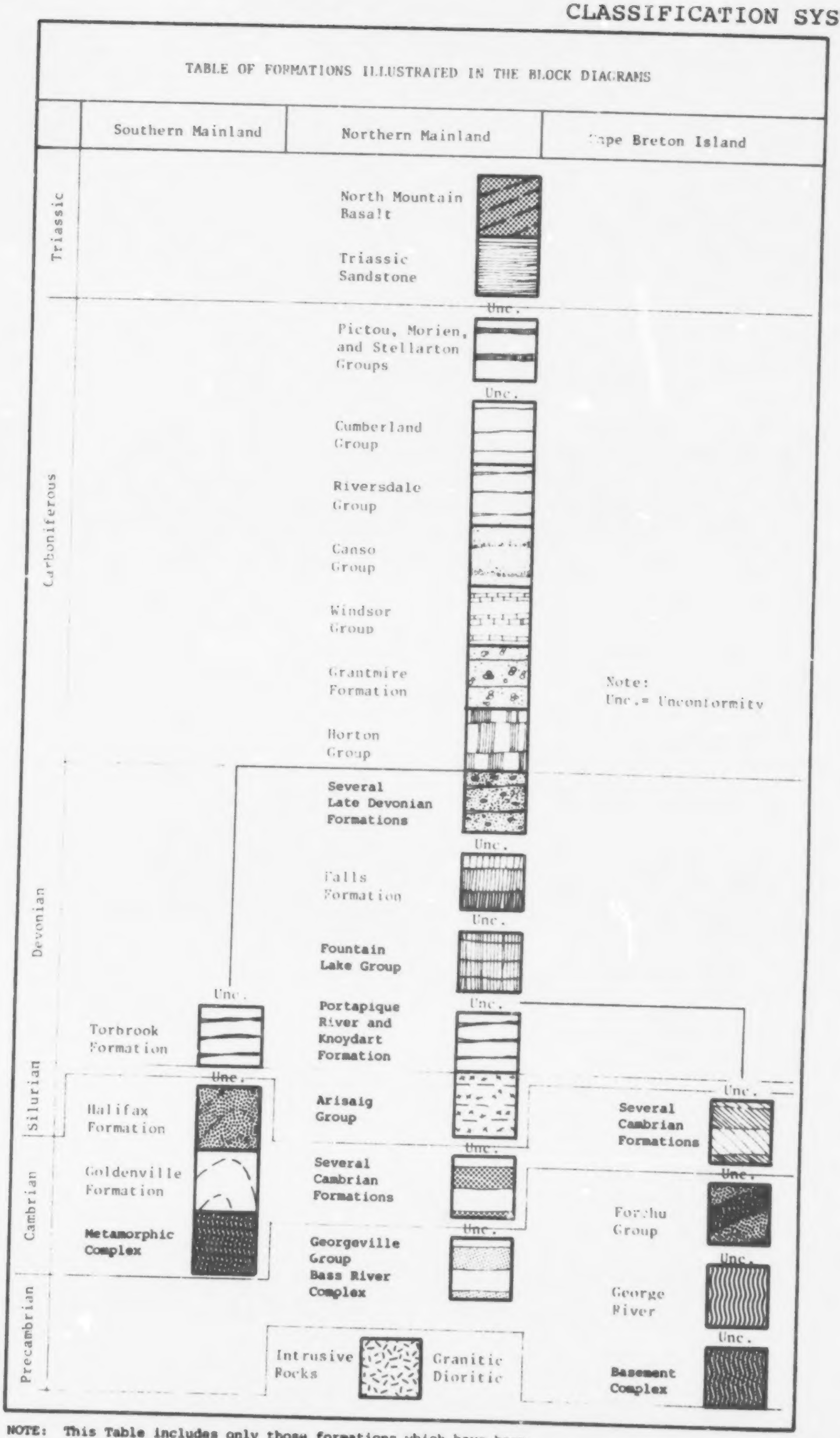


TABLE OF FORMATIONS ILLUSTRATED IN THE BLOCK DIAGRAMS

	Southern Mainland	Northern Mainland	Cape Breton Island
Triassic		North Mountain Basalt Triassic Sandstone	
Carboniferous		Unc. Pictou, Morien, and Stellarton Groups Unc. Cumberland Group Riversdale Group Canso Group Windsor Group Grantmire Formation Horton Group	Note: Unc.= Unconformity
Devonian	Unc. Torbrook Formation Unc.	Several Late Devonian Formations Unc. Falls Formation Unc. Fountain Lake Group Unc. Portapique River and Knoydart Formation	
Silurian	Halifax Formation	Arisaig Group Unc.	Unc. Several Cambrian Formations Unc.
Cambrian	Goldenville Formation Metamorphic Complex	Several Cambrian Formations Unc.	Forchu Group Unc.
Precambrian		Georgeville Group Bass River Complex Intrusive Rocks Granitic Dioritic	George River Unc. Basement Complex

NOTE: This Table includes only those formations which have been represented in block diagrams. For a complete list of formations please see Keppie, Geological Map of Nova Scotia (1979).

Regional Descriptions

Each Regional description includes information on the Regional character, geology, landscape development, climate, soils, vegetation, fauna, sites of special interest, associated topics and associated habitats. Additional subjects are included as required, while in some cases the headings are combined.

As previously described a hierarchical approach is used. It is suggested that for any particular Unit the reader first reads the Regional description, secondly the District description and lastly the Unit description; generally more specific information will be found at each succeeding level of description. Associated topics and habitats are not repeated in the District and Unit descriptions if they are first noted in the Regional description.

A general map precedes each Region, showing the Region and its component Districts. A more detailed map, at 1:500,000 showing all the Units is included in the back pocket. Boundaries are necessarily approximate and should be regarded as narrow zones rather than lines.

Nineteen plates illustrate the relationship of the Regions, Districts and Units to each other, the topography and geological structure. These block diagrams are intended as schematic depictions of the landscape; particular locations are only used to assist the reader's orientation.

The geological legend immediately following this introduction applies to all the plates. It is derived from the Geological Map of Nova Scotia, but usually shows only "Groups" of rocks rather than the separate formations. A legend is also attached to each plate.

More is known about the earth science aspects of most parts of Nova Scotia than is known about the life sciences. The reader's assistance is especially sought in augmenting life science information concerning any Unit.

Sites of special interest, listed in each Unit description are drawn from several sources; the final report of the International Biological Programmes', Conservation of Terrestrial Environments, Maritime Provinces Committee which identifies proposed ecological conservation sites; a list of provincial parks and park reserves (each is named, although for many there is no detailed information available) and the personal knowledge of many of the reviewers listed in the acknowledgements.

100

100 PLATEAU-TAIGA

REGIONAL CHARACTERIZATION

The plateau surface over 1,700 feet (500 m) is the highest part of Nova Scotia; its height results in a harsh climate with extreme exposure to winds and a very short growing season. Dwarf spruce-taiga; a combination of dense spruce, blanket bogs and barrens dominates the vegetation, providing summer Moose habitat.

GEOLOGY

In the Plateau Taiga Region some of the oldest rocks in Nova Scotia are found. A long history characterized more by periods of erosion than deposition has led to the exposure of these previously deeply buried rocks which now form the highest elevations in the province.

Geologically the Plateau Taiga is part of the Cape Breton Highlands fault block, and has only a few of the several rock types which are found in complex relationships throughout the larger area. The bedrock is predominantly composed of the severely altered rocks, some of which have been distinguished as the George River Group. These rocks were originally deposited during Precambrian times, possibly as marine sediments. During subsequent deep burial they were severely altered by heat and pressure to hard, banded crystalline rocks called schists and gneisses.

The schists and gneisses are cut by granites that range in age from Precambrian to Devonian-Carboniferous. Granite is believed to be the product of deepseated upheaval caused (in this case) by the collision of crustal plates.

The granites cut the schists and gneisses in a complex manner. The intrusive nature of the granite, especially its cross cutting contact with the surrounding rocks, can be seen in several places.

Any sediments deposited above these basement rocks have long since been removed by erosion. There almost certainly were great thicknesses of Carboniferous sediments covering this area at one time. Part of the Carboniferous cover is found as patches on the slopes of the Highland block and as a more or less continuous fringe at lower elevation. This indicates that the present landscape was created prior to the Carboniferous; that the cliffs, slopes and plateau are all exumed features of an ancient landscape.

The absence of any sedimentary rocks younger than Precambrian means that there is no evidence of palaeoenvironments which may have existed in this area for a period of about 600 million years before the Pleistocene glaciation.

LANDSCAPE DEVELOPMENT

1. Uplift and Erosion — The Taiga Region represents an ancient deeply eroded landscape which is presently undergoing imperceptably slow morphological change. However, it is not low-lying, but includes the highest elevations in the provincial landscape. This is attributable to several causes:
   - the plateau is on the highest side of the tilted planation surface or peneplain.
   - the hard mass of the Highlands was very resistant and less affected by the renewed cycle of erosion in the Tertiary than the surrounding softer sediments.
   - the block itself appears to have moved vertically upwards after the overlying Carboniferous strata were deposited.

2. Glaciation — Glaciation during the past one million years has left a veneer of compacted glacial till over about fifty percent of the Taiga Region but no stratified ice-contact deposits or glacial outwash material. The ice cover which engulfed the Highlands during the last phase of ice advance (the Wisconsin) was reduced to an icecap in the later stages. From this relatively static ice cap glaciers radiated

down the steep slopes of the Highlands, scouring the surface, reworking and redepositing rock debris. Underneath the ice-cap itself the surface appears to have been relatively protected. Evidence of permafrost in the area of the Taiga indicates that deep freezing more than scouring was significant in this region. Evidence of some glacial movement is found, however, in the form of glacial striae and plucked bedrock.

3. Recent Evolution

The surface of the Taiga is undulating, with low hills and shallow valleys. It is exposed and barren. There are large areas of bare bedrock but little evidence of active erosion. The gradients are such that streams are sluggish and have little erosive power. Material loosened by freeze-thaw action tends to remain in place.

Streams which drain the Taiga have a radial pattern overall but maintain a somewhat irregular or deranged character individually until the steeper gradients are reached at margins of the plateau.

CLIMATE

The climate of the Taiga region is most heavily influenced by the elevation of the area. Its main features are harsh winters, short summers, exposure to almost constant winds, and high precipitation.

Because of the absence of weather stations in this area, precise weather records are not available. In general, winters are long and cold. Spring is very late, and summer is cool and short. While the estimated mean annual temperature, less than 41°F (5°C), is not markedly colder than other areas in the Maritimes, the daily temperature range is considerably greater. Short-term observations in summer indicated that daily minimum temperatures were from 50° to 57°F (10° to 14°C) lower on the plateau than along the coast. The first freezing temperatures were recorded as early as September 8. There is good reason to believe that in some years minimum temperatures will drop below freezing during every month.

The total annual precipitation is in excess of 64 inches (1,600 mm) a year, the highest in the province.

Over a quarter of this falls as snow, more than 160 inches (400 cm). However, snowfall accumulations are not as great as might be expected. For example, at the end of February the Cape Breton Highlands have a median snow cover in excess of 20 inches (50 cm), while northern New Brunswick, where the total annual snowfall is similar, has a median snow cover greater than 40 inches (100 cm). The presence of crusted layers within the snow cover indicates frequent episodes of rain and thawing through the winter.

The snowpack stays for a long time. In some north facing hollows it may still be present in June. The peak run-off period in the Cape Breton Highlands is May. Elsewhere in the province this occurs in March and April.

Wind records suggest that abnormally strong winds blow in northern Cape Breton during much of the year. The Taiga region is an exposed plateau, offering very little shelter. Low cloud cover or fog is common and relative humidities are high.

The Taiga region has a very short growing season - probably six to eight weeks shorter than adjacent areas on the coast. The frost-free period is substantially shorter than 100 days. The winds have a very adverse impact on the growth of vegetation. Ice blasting causes trees to be dwarfed and stunted. Organic matter tends to accumulate, partly because the time available for decomposition is so short.

SOILS

This area was not mapped in the soil survey of Cape Breton Island because of inaccessibility. However it is now known that the gneisses and other metamorphic rocks which predominate have produced sandy loams varying in depth from zero on rock outcrops to almost 5 feet (1.5 m) over much of the area. It is evident that soil depth is not the factor limiting tree growth. Soils are usually ferro-humic Podzols, Gleysols or organic according to drainage conditions. Surface organic layers are deep and many areas are covered by several decimetres of dry, semi-decomposed organic material. The most significant feature is the major accumulations of sphagnum and sedge peat. These peat accumulations grow both horizontally and vertically.

VEGETATION

The Plateau Taiga Region corresponds with Louck's Spruce-Taiga Zone. The main influences on the regional vegetation are the harsh winter climate, the high precipitation and the poorly drained terrain. The cold wet conditions favour conifers, bog (H.14) and barren (H.17) vegetation. Winds and ice blasting result in stunted krummholz trees. Short, dense spruce and fir alternates with shrub barrens and peat bogs.

In the few areas where soils are deep and well drained, a relatively stable association of stunted Black Spruce, White Spruce, Balsam Fir and White Birch occurs. Mountain Ash is scattered along stream sides and Balsam Fir forms almost pure stands. Barrens occur on shallow soils on low ridges; while sedge and sphagnum bogs occur in depressions, and on seepage slopes. The high plateau barrens are characterized by exposed, dwarfed and stunted Black Spruce and Balsam Fir, deep surficial humic layers, Reindeer Moss and other lichens, Blueberry, and Sheep Laurel. Although it is quite possible that fires were originally an important factor in the development of the Taiga barrens, the presence of advanced barren vegetation indicates that fires have not occurred for a long period of time. Peat bogs are characterized by a variety of sphagnum species, bulrushes, Beak Rush, Cranberry, mosses and liverworts. In many cases, the bogs contain ponds either arranged in a concentric configuration around a domed centre, or in a random pattern on a flat surface.

Relict arctic-alpine plants are an important feature of this Region's vegetation. Two species of birch, Betula glandulosa and B. borealis, and the Alpine Whortleberry are particularly associated with this area. Others, such as the Curly Grass Fern, are also found in bogs at a much lower altitude.

FAUNA

The barren and bog vegetation in this Region does not support a large or diverse fauna population. Small mammals likely to be present in the bogs and barrens include the Common

Shrew and Red-backed Vole. The Region provide some Lynx habitat. Moose and bear also sometimes use the area. Breeding birds are relatively few but include the Greater Yellow-legs and the Grey-cheeked Thrush. Relict arctic aquatic animals are found in the small dystrophic lakes.

SPECIAL AREAS Sunday Lake (IBP Proposed Ecological Site 20)
- example of high plateau with boreal forest, bogs and barrens with rare arctic-alpine plants.

ASSOCIATED TOPICS

T3 Formation of the Appalachian Region and the North Atlantic Ocean, T11 Development of the Ancient Landscape, T13 Glaciation, T15 Post-glacial Climatic Changes, T20 Nova Scotia's Climate, T42 Trees, T47 Rare Plants.

ASSOCIATED HABITATS

H14 Blanket and Raised Bogs, H17 Barren, H31 Balsam Fir Forest, H32 Spruce, Fir-Maple, Birch Forest.

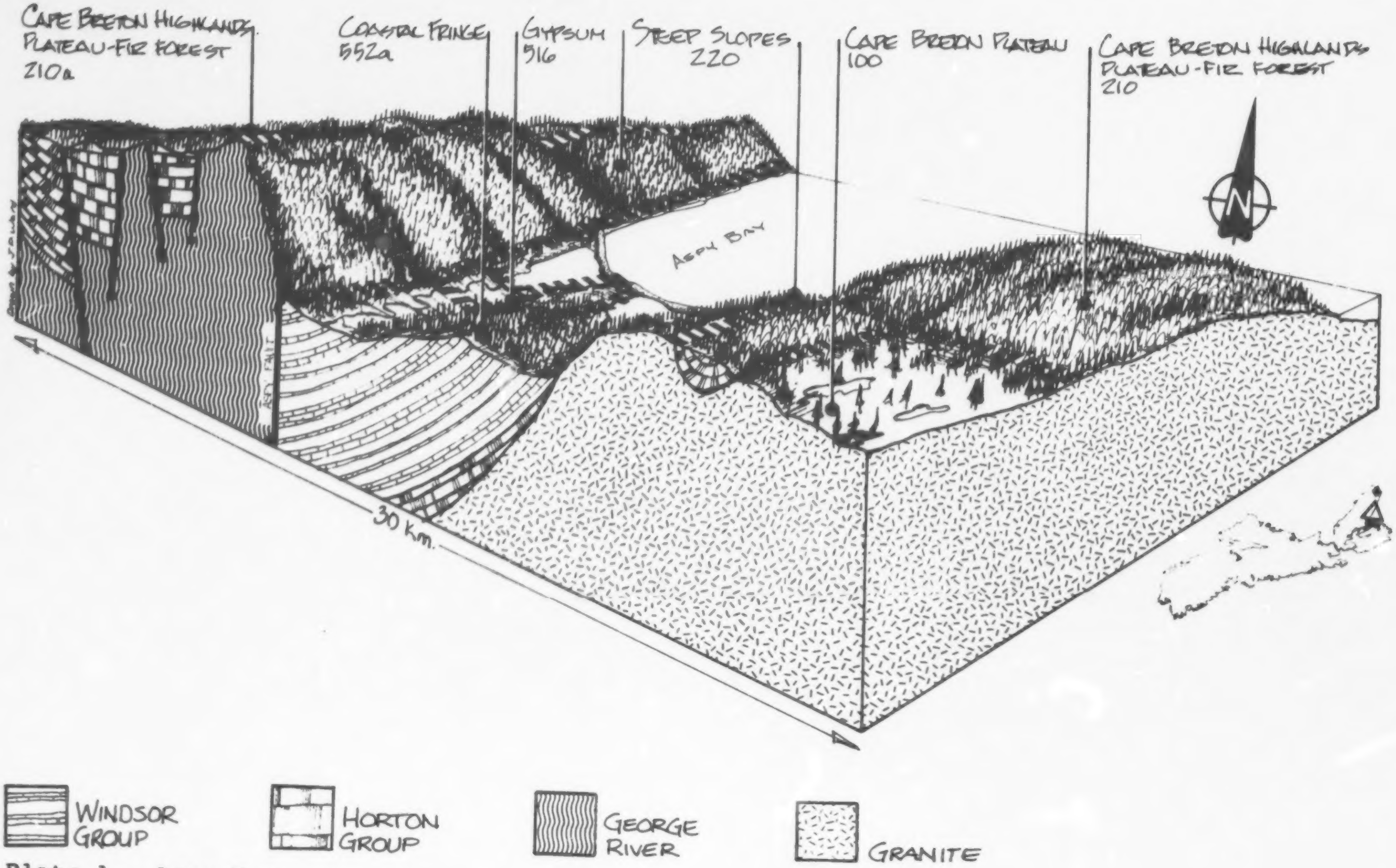
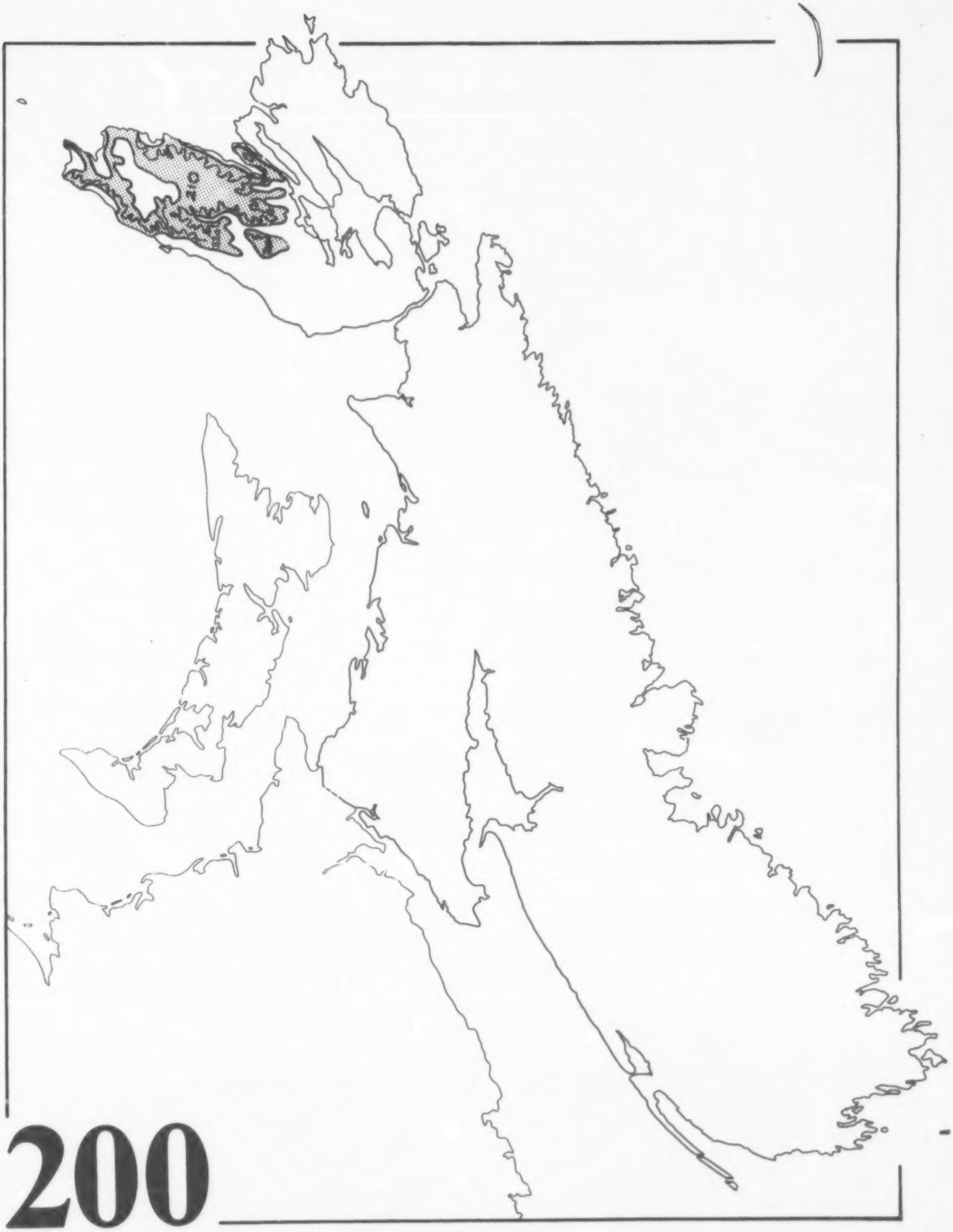

CAPE BRETON HIGHLANDS PLATEAU-FIR FOREST 210a
COASTAL FRINGE 552a
GYPSUM 516
STEEP SLOPES 220
CAPE BRETON PLATEAU 100
CAPE BRETON HIGHLANDS PLATEAU-FIR FOREST 210
ASPY BAY
ASPY FAULT
N
30 Km.
WINDSOR GROUP
HORTON GROUP
GEORGE RIVER
GRANITE

Plate 1. Aspy Bay

The straight, steep scarp (220) of the Aspy Fault separates the northern extention of the Cape Breton Highlands Plateau-Fir Forest (210) from the Coastal Fringe (552). In the foreground the Taiga vegetation of the Cape Breton Plateau (100) above 1,700 feet (500 m) is seen on the granite massif which dominates northern Cape Breton Island.



200

200 HIGHLANDS

REGIONAL CHARACTERIZATION

Northern Cape Breton Island is dominated by a highland block of ancient metamorphic and granitic rocks. Deep valleys which dissect all sides of the block, are habitat for damp, cool, deciduous forests (220). On the southward sloping plateau surface, generally above 1,000 feet (300 m), the short growing season and severe climate allow only a Balsam Fir forest to grow (210).

GEOLOGY

The Highlands are made up predominantly of ancient Precambrian rocks. They were originally volcanic and sedimentary deposits which have been altered to dark, crystalline banded rocks called schists and gneisses. Those known to have had a sedimentary origin as muds, sands, limestone are called the George River Group. Amongst the remaining schists and gneisses other units of the George River Group may eventually be separated out as more detailed mapping is completed.

1.Oldest Granite

The complex history of the Highlands may be summarized as follows:
The early depositional environment in the area was interrupted by crustal plate collision. This resulted in the intrusion of granites during the Precambrian and Cambrian periods and in the metamorphism of the sedimentary and volcanic rocks.

2.Pre-Devonian Erosion

During the 350 million years from Cambrian to Devonian Cape Breton was a land area. Any sediments deposited during this period were lost through subaerial erosion and no evidence remains of the palaeoenvironments existing at that time.

3.Acadian Orogeny Second Period of Granite Intrusion	The next event recorded in the geological record is the upheaval of the Acadian Orogeny which took place in the late Devonian. At that time the sediments of the Meguma group were compressed against the Avalon Zone as the supercontinent Pangea began to form. The Meguma sedimentary rocks occur strictly south of the Glooscap Fault system (this runs roughly from Cape Chignecto to Chedabucto Bay) but the crustal upheaval caused granites to be emplaced both in Cape Breton and throughout mainland Nova Scotia. In the Highlands the Devonian/Carboniferous granites are found in a line from Aspy Bay to Lake Ainslie.
4.Carbon-iferous Sea	In the long period during which Nova Scotia was part of Pangea, sediments deposited in the Carboniferous Sea eventually covered the entire Highland area, probably to a considerable depth. Only occasional remnants of these strata are now found on the Highland plateau eg. the block of Canso Sandstone (late Carboniferous) which can be seen near the western entrance to the Cape Breton Highlands National Park. During the late Carboniferous, the Highland block appears to have moved vertically upwards and pushed through the Carboniferous strata. In places these can be seen to be domed upwards at the margins of the Highland.
5.Mesozoic: Erosion	During the time interval between the Permian and Cretaceous periods the Highlands underwent a second period of deep erosion during which the Carboniferous strata were stripped from the ancient basement rocks and the region became part of the planation surface that extended across the Maritimes.
6.Tertiary, Uplift and Erosion	During the Tertiary the planation surface was uplifted and tilted. Since then the third period of erosion once more exploited variations in resistance of the rocks across the flat eroded surface. The Cape Breton Highlands are situated on the highest part of the tilted plain and have thus been subject to the greatest degree of erosive attack.

LANDSCAPE DEVELOPMENT

Faulting

In addition to the elevation of the Highland block an important element of its morphological character is the combination of faults which are found both around its margin and cross cutting the interior. The boundaries of the Highlands are in places depositional - softer Carboniferous strata have been deposited directly onto the older metamorphosed rocks - and in places faulted. Either way erosion has preferentially exploited the softer material and exposed a steep scarp slope at its margins. Faulting has defined the straight sides of the Highlands on the east and west and influenced the angular drainage patterns of many rivers and streams. The two main fault directions are NNE and WNW, with the former predominating.

The principal fault in the Highlands is the Aspy Fault which runs southwards from Cape North. For 15 miles (40 km) its position is manifest by a straight escarpment that continues across the Highland as a straight line of river valleys reappearing on the south side in the Margaree River Valley. The Aspy is an ancient fault which shows evidence of movement dating back to the Ordovician period. Other faults have also been exploited by rivers which rise well towards the interior of the Highlands and form long steep-sided, v-shaped valleys at the margins eg. Grand Anse River, Ingonish River. These rivers do not develop flood plains or wide intervales until they leave the Highlands, however, an exception to this general rule is the Margaree River which has a broad intervale extending well into the Highlands.

Some upland masses are isolated by faults, for example Sugar Loaf Mountain in the interior, and Gairloch Mountain on the southerly margin of the Highlands.

Further details of the geomorphology are included at the district level under:

210 Pre-Cambrian Highland; Fir Forest.
  a) The Highlands
  b) Gairloch Mountain
220 Steep Slopes

CLIMATE

The climate of the Highlands Boreal Forest Region is influenced both by elevation, and by winds blowing off adjacent ocean waters. Its main features are cold, long winters; short, cool summers; and high precipitation. It differs from the climate of the Highland Taiga Region mostly in terms of the lesser impact of the wind. (see Region 100: Highlands Taiga)

Because there are no weather stations in the Region, detailed climatic information is not available. While the mean annual temperature less than 14°F (5°C) is not markedly colder than other areas in the Maritimes, the daily temperature range is considerably greater. The beginning of winter, as marked by a continuous layer of snow 1 inch (2.5 cm) deep, usually occurs in the Highlands in early or mid-November. Snowfall is heavy, but accumulations are limited by frequent episodes of rain and thawing. Records for weather stations in an adjacent region at Cheticamp and Ingonish Beach show that mean daily temperatures in January, February and March are consistently lower at Cheticamp, reflecting the influence of winds blowing mainly from the north and north-west over the frigid ice covered waters of the Gulf of St. Lawrence. This east-west difference is also noticeable in parts of the Highlands.

Summer temperatures start to rise sharply in May, and fall abruptly in September. Mean daily temperatures in July are somewhat cooler in the Highlands than in most other interior areas of the province.

Over 64 inches (1,600 mm) of total precipitation falls each year in the highest areas of the Region. Elsewhere amounts range between 56 and 64 inches (1,400 - 1,600 mm). The effects of an Atlantic rain shadow are evident, with higher precipitation recorded on the eastern side of the Region. Over 160 inches (400 cm) of snow fall on most of the area, with lesser amounts being recorded on the Atlantic side because of the slightly warmer winter temperature. The snow cover melts in late April or May.

Many days in the year this Region is shrouded in fog or low-level clouds, and relative humidities are high. Interesting microclimatic features include cold-air drainage and fog in the canyons, and the high relative humidity and low sunlight exposure of north facing cliff walls in steep walled canyons.

The growing season is short, but tree growth is rapid, except where strong winds stunt growth on exposed ridges.

SOILS

This area was not mapped in the soil survey of Cape Breton Island because of inaccessibility. However, it is now known that the soils are in fact considerably better than the blanket designation, "Rough mountain land", would suggest. The soils are mostly heavily podzolized sandy loams, which are surprisingly deep considering that the underlying rocks are highly resistant. This suggests that the Highlands were protected by a static ice cover during the last glaciation. One interesting feature is the steeply sloping sides of the Highland plateau surface.

VEGETATION

The Cape Breton Highlands Region falls within Louck's Gaspe - Cape Breton Ecoregion. Balsam Fir, White Birch and White Spruce are the main species, forming what is essentially the true boreal forest region in Nova Scotia (H.31). The main influences on the regional vegetation are cool temperatures, high precipitation and the effects of wind and insect damage. Because of inaccessibility cutting has not been a major disturbance factor until the last decade. Since the Spruce Budworm Salvage Project large areas of dead Balsam Fir have been removed. Replanting with Black Spruce is taking place in some areas. Stands of fire origin are present but uncommon.

On the slopes fringing the plateau the true boreal forest is replaced by the Acadian forest association - tolerant hardwoods (H.27) along the steep-walled canyons on the eastern and western coasts, and predominantly softwoods on the Atlantic slope in the north-east corner of the region. The tolerant hardwoods - Yellow, Birch, White Birch, and Sugar Maple - are mainly found between 650 feet and 1,000 feet (200 m and 300 m) above sea level. On the plateau, barrens and bogs are common.

This Region is interesting because of the diversity of floral elements represented. The northernmost limit for Alleghanian tree species (for example, Sugar Maple) in the Atlantic Provinces is found here. Also represented are the Arctic-Alpine element and the Cordilleran element. The Cordilleran flora in Cape Breton is usually restricted to wooded ravines, or damp, cool deciduous and mixed woods. They are more commonly found in similar cool, moist habitats on the Pacific coast or along the Rocky Mountains.

FAUNA The fauna of this region reflect its boreal character, and also its status as one of the few large areas which remain relatively inaccessible. Boreal species such as the moose, Snowshoe Hare and lynx are found here. The larger carnivores, such as bear and perhaps cougar, are given the large range of undisturbed habitat which they require. Also present here are disjunct species with a generally northern or mountainous distribution elsewhere - for example the Rock Vole, and the Gaspé Shrew. The region offers a wide range of habitats, which include more areas of mature woodland, both hardwood and softwood, than are found in the other regions. Other habitats include bogs, barrens, cliffs and talus slopes.

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T5 Granite in Nova Scotia, T11 Development of the Ancient Landscape, T20 Nova Scotia's Climate, T31 Soil Development and Soil Climate, T43 Plant Communities in Nova Scotia, T56 Ungulates, T57 Carnivores.

ASSOCIATED HABITATS

H11 to H16 Freshwater Habitats, H19 Cliff, H20 Talus, H27 Sugar Maple, Yellow Birch, Beech, H32 Spruce, Fir-Maple, Birch Forest.

210 Plateau-Fir Forest

a) The Highlands
b) Gairloch Mountain

GEOLOGY AND GEOMORPHOLOGY

The undulating plateau crest of the Cape Breton Highlands is dissected by faults into two parts, the Highlands (including part of Kellys Mountain) and Gairloch Mountain (an isolated section on the southern fringe). The plateau surface is tilted to the southeast; the average elevation drops from about 500 m to about 400 m at the edge of the Highlands. This may represent the slope of the original upland surface.

Exposure to long periods of erosion has uncovered severely altered rocks on the Cape Breton Plateau that were once deeply buried. These rocks are very hard and resistant and at present are being eroded very slowly. Even the last glaciation did little to modify the plateau surface. There is some controversy about the exact sequence of events during the Wisconsin ice advance across Cape Breton, but it appears that the Highland was covered by an ice-cap at least during the later stages. This ice cap may have protected the underlying plateau but generated glaciers which radiated down the marginal slopes. The glacial deposits on the plateau surface are dominated by compacted subglacial till. Exposed bedrock may be ice-plucked or display striations. Erratics are common.

The drainage pattern across the Cape Breton Highlands is radial. Streams flowing on the plateau surface are relatively slow-moving but in their middle sections cascade down the scarp slopes. In many cases the tributary streams appear to follow joint and fault directions very closely, eg. North Aspy River.

Gairloch Mountain is cut-off from the southern part of the Highlands by two major faults. The boundaries of this block are sharp and steep where softer rocks have been eroded away. In the northwest where metamorphic rocks are faulted against resistant early Carboniferous Horton deposits there is no steep scarp slope. Similarly on the south side where there is a depositional boundary with resistant Devonian - Carboniferous rocks, the contact is not topographically distinctive. However, on the north side where easily eroded Windsor deposits are set against the metamorphic rocks there is a pronounced scarp slope.

The maximum elevation of Gairloch Mountain is almost 1,450 feet (430 m), about 300 feet (100 m) less than the highest part of the Highlands. This reflects its more southerly, and therefore lower, position on the tilted planation surface.

The drainage pattern over the district is radial. Individual brooks flowing down the scarp slopes on the north side are short and straight whereas those in the south, where there is no escarpment, tend to have dendritic (branching) tributary patterns.

VEGETATION

The vegetation of the highlands is characterized by largely even-aged, boreal forest, with Balsam Fir, White Birch and White Spruce as the main species. The main successional agents are windthrow and insect damage, particularly Spruce Budworm. Fire influence is mainly restricted to the area behind Neils Harbour, where pure stands of Jack Pine are found. Elsewhere in the district pine is rare.

Typically, in the central and western highlands, the Balsam Fir is 50-75 years old. White Birch readily colonizes openings caused by windthrow, but the fir eventually reasserts itself. White Spruce is scattered through the forest, and often individual trees are much older (150 years) than the surrounding fir. Most of the Balsam Fir has died following Spruce Budworm infestation in the late 1970s. Regeneration is a dense growth of Raspberry with some Elderberry. The only tree species able to survive this competition are White Birch with some Mountain Ash and Pin Cherry. Eventually the birch shades out the Raspberry enabling Balsam Fir to re-establish. Ground vegetation in the mature Balsam Fir forest is often luxuriant. Mountain Maple and Hobblebush frequently form a dense shrub canopy, with Wood Fern, Wood Sorrel and mosses below.

South of the South Aspy River an area dominated by crescent-shaped granite ridges produces a vegetation pattern similar to that found in the Taiga Region - barrens on the dry ridge tops, bogs in the depressions, and open stands of Balsam Fir in between.

On the broad, flat plain which slopes down to the Atlantic Ocean between Neils Harbour and Broad Cove the vegetation has been more influenced by fire and cutting, and is therefore at an earlier successional stage. On the shallow granitic soils Balsam Fir, Black Spruce, Jack Pine and White Pine form younger stands with Bracken Fern underneath.

FAUNA

The fauna found in this district is, for the most part, characteristically boreal in range, though often found elsewhere in Nova Scotia as well. The Snowshoe Hare is plentiful, and the highlands provide some of the last habitat available for its predator, the lynx. The Bob-cat, the lynx's rival, is also found in the area and unconfirmed sightings of the cougar have been reported. Deer and moose are both present. The moose, subspecies Alces alces andersonii, were introduced to the area and are flourishing. Deer use the area for summer range but generally move to the sheltered lower slopes in winter. Sickness, due to the parasite Parelaphostrongylus tenuis, has been identified in about 60% of deer sampled but the seasonal separation of moose and deer during concentration periods has apparently helped retard its transfer between the species.

Northern Cape Breton provides suitable habitat for a small remnant population of Pine Marten, which require climax coniferous forests not found elsewhere. The boreal forest does not support large or diverse populations of small mammals.

Because of the prevalence of Spruce Budworm, resulting in many dead and dying trees, birds that bore into dead wood for insects are abundant, particularly woodpeckers. Nuthatches are also common.

SITES OF SPECIAL INTEREST

The geological and geomorphological features of most interest in the Cape Breton Plateau district are:

- the relationships between the metamorphic rocks and intrusive igneous rocks.
- the banded schists and gneisses.
- faults, fault scarps and fault valleys,
- waterfalls; coastal morphology of cliffs, narrow beaches.
- Geological Highway Map references:
  - 68 Near Fox Back Lake; Precambrian granitic rocks and a view of the intruding gneisses.
  - 69 Aspy Fault scarp.
  - 71 Green Cove; gneisses intruded by pink and white granites.
  - 73 Cape Smoky Lookoff; Precambrian granite intruded by dark coloured diabase dykes.
  - 74 Kellys Mountain Viewpoint (St. Anns Lookoff); a road-cut through Precambrian high grade gneisses from which there is a view across the fault-controlled St. Anns Harbour to the main mass of the Highlands.
- Bras d'Or Lookoff; on Kellys Mountain overlooking Bras d'Or Channel and the Sydney area.
- Cabot Trail between Jumping Brook and Pleasant Bay. View of the plateau and an exposure of granite.
- North of Cheticamp, near Jerome Mountain is a faulted contact between granite and gneiss.
- Cabot Trail, west park entrance; a cliff of Precambrian granite veined with quartz.
- Ingonish, Middle Head peninsula, pink granite cutting dark rocks.
- Sugar Loaf Mountain; a granite mass rising to over 1,500 feet (460 m)
- French Mountain Lake (IBP Proposed Ecological Site 17) - raised and sloping bogs, dystrophic lake.
- French Mountain Bog (IBP Proposed Ecological Site 18) - good example of species - rich minerotrophic bog.

Provincial Parks and Park Reserves

- Kelly

ASSOCIATED TOPICS

T6 The Carboniferous Basin: An Inland Sea, T12 Tertiary Drainage Patterns, T13 Glaciation, T40 Pteridophytes (ferns and their allies), T42 Trees, T44 Vegetation Change, T45 Successional Trends in Vegetation, T49 Forest and Open Habitat Birds, T59 Invertebrates.

ASSOCIATED HABITATS

H14 Rapidly-moving Stream, H16 Blanket and Raised Bog, H17 Barren, H28 Pine Forest, H31 Balsam Fir Forest.

220 Steep Slopes

GEOLOGY AND GEOMORPHOLOGY

The margins of the Cape Breton Highlands are, for the most part, clearly visible. They are marked by steep slopes and deep valleys. In many cases these slopes and valleys have formed along faults where rubbly rocks in the zone of movement have been washed away.

Several important rivers flow in fault-controlled valleys, eg. Margaree, Grand Anse, North Aspy, Warren Brook, Clyburn Brook.

In those places where the metamorphic rocks of the Highlands have a depositional contact with softer, erodible strata, an abrupt change of relief is produced by differential erosion eg. North Bay Ingonish, St. Lawrence Bay, south of the Middle Aspy River. In each of these examples the situation is complicated by faulting.

Unlike the plateau where the undulating terrain is undergoing little modification, erosion is very active in the slopes and valleys. The steep slopes are frequently covered by talus, the product of cyogenic (freeze-thaw) action. The angle of repose of the talus varies according to the texture and coarseness of the material. Rapid downslope wasting is generally impeded by vegetation, particularly where trees and groundcover stabilize the slope. In some places where abundant material is present slumping occurs, in others downslope movement may be manifest in a line of boulders. Waterfalls are common at the edge of the scarp slopes.

Where District 220 intersects the coastline there are steep cliffs which rise almost directly from the sea. There is a very sparse sediment supply and beaches are few and narrow.

VEGETATION

The vegetation of this district is characterized by deciduous woodlands on steep slopes (H.27). Tolerant hardwoods, Eastern Hemlock and White Pine are dominant on the slopes, giving way to early successional White

Birch, White Spruce and Balsam Fir where slopes are unstable or valley bottoms have been disturbed. An important feature of this district is the canyon systems. The canyon slopes are often covered with a mantle of colluvial material in which White Birch, Yellow Birch, Sugar Maple and Balsam Fir grow. Along the western coast the steep slopes are exposed to the influence of the Gulf of St. Lawrence. White Birch, Yellow Birch, White Spruce and Pin Cherry are often stunted by salt-spray laden winds. Insect and diseases have dramatically reduced the significance of beech in this district.

Where Hemlock stands occur, usually on the upper slopes, mosses dominate the ground vegetation. Under mature hardwood stands the fern-Striped Maple association is found with a rich diversity of species.

Arctic-alpine and Cordilleran disjunct plants are found in this district, especially on wet, north facing canyon rock walls and in other shady, moist habitats. These include Rusty, Smooth and Alpine Woodsia, Common Bladderfern, Willowherb, Western Rattlesnake-Plantain, Northern Bedstraw and Sweet Cicely.

FAUNA

Habitats available for the fauna in this district are varied and relatively productive, including mature hardwood forest, conifers, talus slopes, cliffs and moist valley bottoms. The rich well drained soils, deep leaf litter and varied ground vegetation in the predominantly hardwood district is particularly productive with respect to small mammals. In fact the most diverse small mammal fauna in the entire province is found in the hardwood forests growing on talus slopes - fourteen out of twenty species of insectivores and fourteen out of seventeen species of rodents known to occur on Cape Breton Island. The Gaspe Shrew and Rock Vole are found here. Both are relict species, otherwise distributed in more northerly regions, or at high altitudes in mountainous areas. The Rock Vole and Southern Bog Lemming are particularly associated with a combination of talus slope and hardwood forest habitats, most frequently found along the eastern side of the district. The small mammal population is marked more by its diversity of species than by its absolute numbers. One predator which occurs frequently is the Weasel.

The coniferous forests more commonly found on the western side do not provide good small mammal habitat.

The steep slopes (40-45 degrees) inhibit the movements of larger mammals, although deer make use of the hardwood browse in the more accessible areas.

The diversity of vegetation, and the well developed structural profile of the mature hardwood forest, ensures a rich avifauna, dominated by warblers, nuthatches, and woodpeckers.

SITES OF SPECIAL INTEREST

Second Fork Brook (Margaree River)
- waterfall

Indian Brook
- waterfall

Grand Anse River (IBP Proposed Ecological Site 19)
- old growth, deciduous forest on steeply sloping valley, rare arctic-alpine plants including Green Spleenwort (Asplenium Riride).

North Aspy River (IBP Proposed Ecological Site 21)
- old growth, deciduous forest.

French River (IBP Proposed Ecological Site 22)
- old growth, mixed forest, cliffs and talus slopes.

Oregon (IBP Proposed Ecological Site 23)
- old growth, Hemlock stand, above North River.

Second Fork Brook (IBP Proposed Ecological Site 15)
- old growth, Sugar Maple stand.

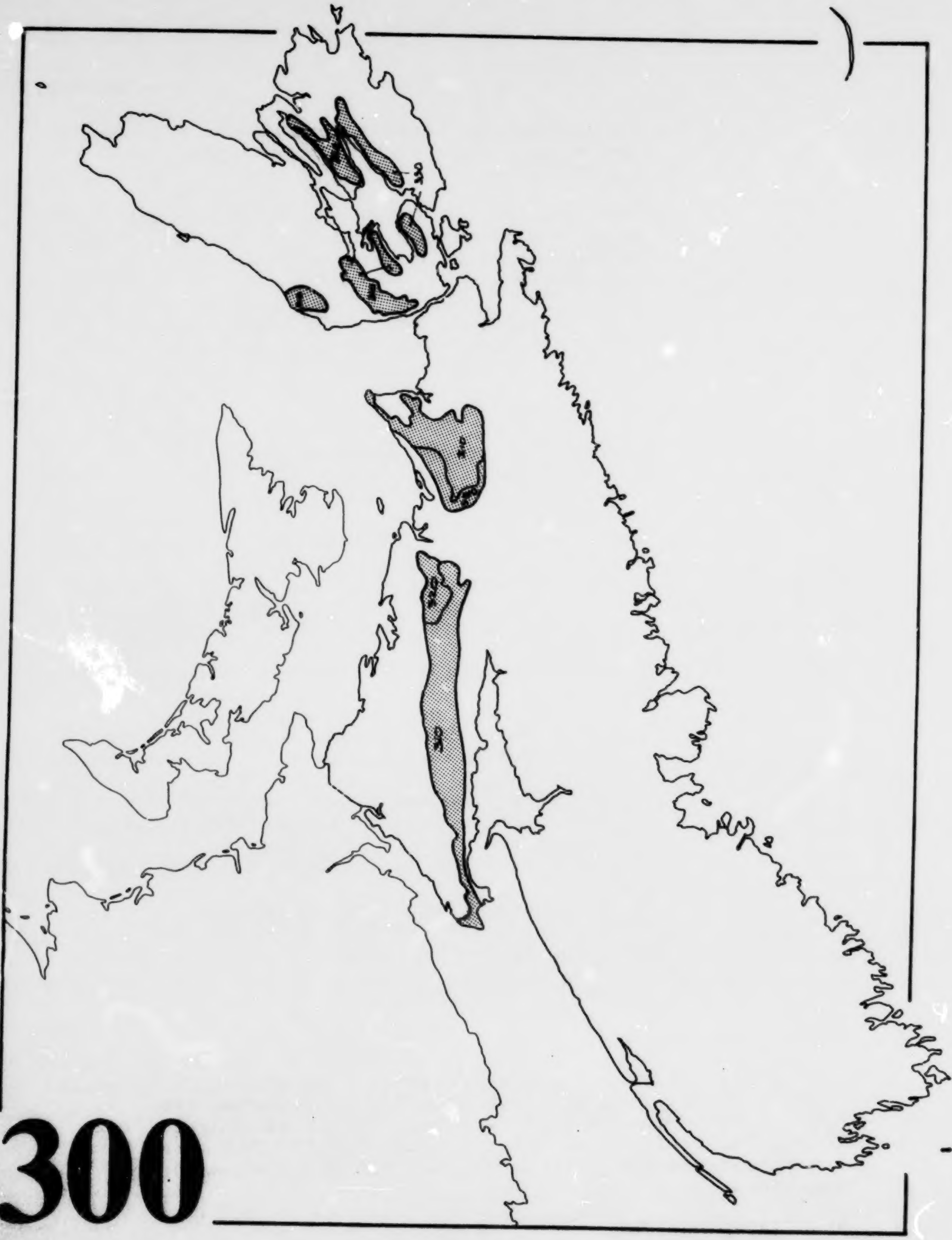
Provincial Parks and Park Reserves
- Cape Smokey
- North River
- South Lake-O-Law

ASSOCIATED TOPICS

T16 Colonization by Plants, T26 Coastal Landforms, T29 General Hydrology, H31 Soil Development and Soil Climate, T39 Bryophytes (Mosses and Liverworts), T40 Pteridophytes, T42 Trees, T43 Plant Communities in Nova Scotia, T47 Rare Plants, T49 Forest and Open Habitat Birds, T55 Small Mammals, T56 Ungulates

ASSOCIATED HABITATS

H22 Maple, Oak, Birch Forest, H25 Spruce, Hemlock, Pine Forest, H27 Sugar Maple, Yellow Birch, Beech Forest, H31 Balsam Fir Forest, H32 Spruce, Fir-Maple, Birch Forest



300 AVALON UPLANDS

REGIONAL CHARACTERIZATION These upland areas experience more severe winters, with greater amounts of precipitation and shorter growing seasons than the surrounding lowlands. Climatic conditions are not as harsh as in Cape Breton Highlands. This climate is reflected in the dominant hardwood vegetation characterized by a Sugar Maple-Yellow Birch-Fir association (H.27). Six of the eight plateaux (district 310) which comprise the region are sharply defined with level plateau surfaces at elevations between 300 and 1,000 feet (200 - 300 m) above sea level. Margins of the plateaux generally fall abruptly 300 feet (100 m) or more, with little dissection by stream valleys. The remaining two uplands (district 330) are at lower elevations with a less severe climate and a greater proportion of softwood trees. Mainland parts of this region are bordered by ancient sedimentary rocks on which the soils are deeper and the river valleys are more deeply carved (district 320). All of these uplands provide excellent moose ranges.

GEOLOGY AND GEOMORPHOLOGY The blocks are made up of very resistant metamorphic and igneous rocks among which are some of the most ancient rocks in Nova Scotia. In most cases the blocks are bounded and often cross-cut by faults. At the margins these give steep, scarp slopes and within the blocks, where harder and softer strata are juxtaposed, they produce rugged hill and valley topography.

The crests of the blocks are often narrow and dissected but are usually uniform in height along their length. They also display a height relationship to one another which is cited as evidence for the existence of a Cretaceous planation surface. The crests progressively decrease in elevation south-eastwards as they intersect an almost uniform surface now dissected and tilted to the southeast. Subsequent erosion has removed soft strata and left the resistant blocks as uplands. Their prominence varies according to the hardness of the adjacent rocks and their position on the tilted peneplain.

Region 300 is divided into three districts on the basis of geology, geomorphology, elevation and climate. These are:

310 Hardwood Plateau
320 Dissected Margins
330 Fault Ridges

CLIMATE

The dominant influence on the climate of this somewhat diverse region is elevation, modified by proximity to different water masses in the different areas. The main features are wide daily and seasonal temperature ranges, and high precipitation, especially snowfall.

Winters are generally long and cold. Because of their greater elevation, the Cobequids record the coldest temperatures within the Region. The uplands south and east of the Bras d'Or Lake are slightly warmer than the rest of the region because of lower elevations and the moderating influence of the Bras d'Or Lake and the Atlantic Ocean. Spring is late, although somewhat earlier in the Bras d'Or area. Mean temperatures do not rise above 32°F (0°C) until April. Summer temperatures are cool at the higher elevations, but warmer towards Cape Breton. Freezing temperatures return before the end of November in the Cobequids and Antigonish Highlands, and one or two weeks later in Cape Breton.

Total annual precipitation exceeds 48 inches (1,200 mm) in the Mainland. The region is noticeably wetter in Cape Breton, where precipitation exceeds 56 inches (1,400 mm). Snowfall is greatest on the highest parts of the Mainland, exceeding 120 inches (300 cm). In Cape Breton 80-100 inches (200-250 cm) falls close to the Bras d'Or Lake, and over 100 inches (250 cm) elsewhere. The snow cover season follows the same pattern, being longer in the Mainland areas (over 140 days) and somewhat shorter (130 days) in the rest of the Region. In midwinter snow accumulations over 15 inches (40 cm) occur in the Cobequids and Antigonish Highlands.

Cloud cover occurs frequently and the relative humidity is high. Exposure to wind is an important factor at the highest elevations and in those areas close to the Gulf of St. Lawrence.

The main features of the bioclimate of the Avalon Uplands are the short frost-free period, the short growing period, cool moist summers, and low evapo-transpiration.

SOILS

The main influences on soils in this Region are the high precipitation, the presence of somewhat more basic igneous rock, steep terrain providing good drainage, and the prevalence of hardwood vegetation. Soils are strongly leached, but in many areas have higher natural fertility than is found in soils on the more acid upland rock. Soils are usually well drained, shallow, stony, sandy loams, often of the Ferro-Humic Podzol great group. Because of low evapotranspiration, substantial levels of organic matter accumulate in the upper layers. Leaf litter from the hardwood forests develops into a mull or moder humus form.

C.D. Howe made the following observations on soil-forest relationships in 1912. "The felsites and syenites are similar to granites .... they vary in hardness, and the softer forms give rise to very vigorous soils which rank with alluvial soils in fertility, while the harder forms results in a soil similar in fertility to that of the more compact sandstones. They are, therefore, feeble soils...."

The more recent Cumberland County Soil Survey (1973) reports; "The somewhat higher base status derived from fero-magnesian minerals may have something to do with the prevalence of hardwood trees in the Cobequid Mountains and the rich undergrowth there, but this effect is difficult to separate from the adverse effect of exposure on the conifers."

VEGETATION

Most of the Region falls within Louck's Sugar Maple - Yellow Birch - Fir zone and these are the predominant species. Parts of the Region, south and east of the Bras d'Or Lake, are in the Sugar Maple - Hemlock - Pine zone. The major influences on the regional vegetation are the fertile soils, cold winters and cool summers, good drainage and relative lack of disturbance. The high elevation and well drained fertile sites favour hardwoods (H.27) or mixed woods with softwoods appearing on poorly drained sites and cool, moist ravine slopes and valley bottoms. Shallow soils on parts of the plateau surfaces support only Balsam Fir with lesser amounts of spruce (H.29).

Sugar Maple, Beech and Yellow Birch are the main species on the hills (H.27). White Spruce, Red Spruce (mainly in the Cobequid Hills) and Balsam Fir form mixed or softwood stands on valley slopes, while Black Spruce, White Spruce, scattered Hemlock and White Pine (H.23) predominate on the valley bottoms. A prominent feature in this Region is the vigorous shrub growth, particularly Mountain Maple, Witch Hazel and Hobblebush. This shrub growth is released in cut-overs and insect killed stands, with the prominent addition of Raspberry. Following disturbance intolerant hardwoods are found throughout but are more prevalent on lower slopes, mixed with the conifers, spruce and fir (H.24).

There are few bogs in this Region, but seepage sites are common.

Plants of the Alleghenian floral element, whose main range is further south, are associated with intervale habitat in this Region.

FAUNA This Region provides a range of forested habitats, but does not include significant aquatic habitats. Its main importance is that it includes large areas which are relatively undisturbed and inaccessible. These provide good habitat for ungulates, bears and the larger carnivores.

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T4 The Avalon and Meguma Zones, T6 The Carboniferous Basin: An Inland Sea, T11 Development of the Ancient Landscape, T16 Colonization by Plants, T20 Nova Scotia's Climate, T31 Soil Development and Soil Climate, T42 Trees, T43 Plant Communities in Nova Scotia, T56 Ungulates.

ASSOCIATED HABITATS

H13 Rapidly-moving Stream, H23 Spruce, Fir, Pine Forest, H24 Spruce, Fir, Pine-Maple, Birch Forest, H27 Sugar Maple, Yellow Birch, Beech Forest, H29 Spruce, Fir Forest.

310 Hardwood Plateau

Within this District are grouped a number of fault blocks in northern mainland Nova Scotia and Cape Breton which are positioned on the up-tilted northern side of the planation surface. Highest elevations of each block are about 1,100 feet (340 m), although the plateau surfaces vary down to 900 feet (275 m). Their similar elevation and northerly position on the planation surface give areas within the District common climatic characteristics.

Within District 310 there are four units, two on the mainland and two in Cape Breton. Each has distinctive geological and geomorphological features.

Units:
- 311 Cobequid Hills
- 312 Pictou-Antigonish Highlands
- 313 North Bras d'Or Uplands
  - a) Creignish Hills
  - b) North Mountain
  - c) Boisdale Hills
- 314 Mabou Highlands

UNIT 311: COBEQUID HILLS

GEOLOGY

The Cobequid Hills are the surface expression of a steep-sided, elongated fault block, a slice of Avalon crust, which forms a highland on the north side of the Minas Basin. It is a resistant massif surrounded by the more easily eroded and low-lying Carboniferous and Triassic sediments.

The geology of the Cobequid Hills is dominated by metamorphosed sediments, granites and volcanic deposits which range in age from Precambrian to Devonian. These have been crushed, folded and faulted. The geological complexity is manifest in rapid changes of rock type within a short distance.

Precambrian Basement Rocks

The oldest rocks are those of the Bass River Complex, found from Economy River to Nuttby and in the Central New Annan area; and the Mt. Thom Complex, exposed at Mt. Thom. These rocks were originally both sedimentary and volcanic deposits but have been metamorphosed to schists and gneisses. They form part of the Precambrian basement upon which deposition took place in the Silurian. Included in this basement are altered granites which were intruded during obscure early phases of crustal upheaval.

Overlying Sedimentary Rocks

There are no Cambrian strata in the Cobequids but deposition appears to have been continuous from the Silurian through to the Devonian and Carboniferous. Many different rock types are represented. The early (Silurian) deposits of fossiliferous siltstone and shale are interleaved with various types of volcanic deposits such as ash (tuff) and flows (ignimbrites and lavas). These give way to younger (Devonian) non-fossiliferous red beds which can be correlated to the Knoydart Formation in the Pictou-Antigonish area. The red beds were deposited in shallow, fresh water and are thought to represent the retreat of the sea prior to the Acadian crustal collision which lead to the formation of Pangea. Middle Devonian deposits include more volcanic rocks. Late Devonian strata include coarse sediments which continue into the Carboniferous.

Acadian Orogeny

The Acadian Orogeny caused the crushed and folded sediments to begin melting and mobilizing deep within the crust. The resulting granitic liquid rose and cooled forming large intrusive bodies. These granites, together with their older counterparts now represent over 40% of the bed rock underlying the Cobequid Hills.

Surface Exposure of the Fault Block

Although the Cobequid Hills have ancient origins they did not become a topographic feature until after the Cretaceous. The block appears to have begun moving vertically upwards via fault movement during the Carboniferous but was deeply covered by sediment at that time. Unlike other areas in the Avalon Uplands, it did not form an island in the Carboniferous Sea.

The block lies on the upper side of the uplifted planation surface and has remained as a resistant highland while the surrounding softer Carboniferous and Triassic sediments have been stripped away.

GEOMORPHOLOGY

The Cobequid Hills form a cigar shaped block which is about 75 miles (120 km) long, 9 1/2 miles (15 km) wide and is, on average, 900 feet (275 m) high. The crest is a narrow featureless plateau which ends abruptly at faulted margins on both the north and south sides.

Faults

The southern boundary is the scarp of the Cobequid Fault which is the westerly continuation of the Chedabucto Fault. This fault which can be traced from Truro to Cape Chignecto is obscure in the east but in the west it has a steep and prominent scarp slope. The fault zone is best exposed along the beach just west of Port Greville. It is also visible at Bass River as a 300 foot (100 m) band of crushed rock. East of Parrsboro it appears as a series of high cliffs and steep hills which are skirted by the road. From Parrsboro to Diligent River the highway follows the contact between the resistant older rocks on the northside and the Carboniferous lowlands to the south. Beyond Fox River the fault follows the north shore of the Minas Channel, becomes obscure around Advocate, and runs seaward off high cliffs at Cape Chignecto.

The northern boundary of the Cobequids runs from Earltown to River Philip. Although there is an abrupt drop to the rolling northern plain the slope decends more by a series of steps than as high cliffs. The fault on the northern side is covered by Carboniferous deposits.

Within the Cobequid Hills other east-west faults divide the block into long slices, however, these have little topographic expression since they juxtapose rocks of similar hardness.

Drainage

The Cobequid Hills form a drainage divide across northern mainland Nova Scotia. The streams rise in the lakes and bogs on the till-blanketed crest then plunge down the scarp slopes in waterfalls, cascades, and straight, steep-sided gorges. The falls and gorges are most spectacular on the south side, for example along Economy River, Moose River, Bass River and Portapique River. On the north side falls can be seen east and west of New Annan. Generally the valleys tend to be wider on the north side. In some cases a new channel has been cut in the centre of a wider, shallow valley, for example along the Folly River where the river occupies a central narrow gorge 65-100 feet (20-30 m) deep.

The crest of the Cobequids is relatively even and undissected except for two places where it is cross cut by major valleys: the Parrsboro and Folly Gaps. The Parrsboro and Folly Gaps are believed to be the abandoned valleys of rivers which at one time may have flowed southwards from the Gulf of St. Lawrence. They were superimposed upon the massif as it rose and became exposed and cut deep channels across its surface. The remnants of these rivers now flow northwards and may be represented by the River Hebert and the Wallace River. The floor of both the Parrsboro and Folly Gaps are covered by glacial debris including thick deposits of gravel. Folly Lake has formed between dams of gravel at either end of the valley. Water seeps through on both sides to form the headwaters of the Wallace and Folly Rivers.

Along the sides of the Parrsboro Gap there are glaciofluvial gravel terraces and kames. Other kames and kame terraces in the centre of the valley cut off several small lakes.

SOILS

The soils derived from the igneous and metamorphic rocks in this unit are stoney, usually shallow, and extremely acid, gravelly, sandy loams. Over large areas the bedrock is within 1.5 feet (0.5) m of the surface, and rock outcrops are common. The Cobequid series covers most of the area. This well drained sandy loam is an excellent forest soil, providing a porous but solid rooting medium. The cool, moist climate is responsible for the accumulation of colloidal organic matter in these soils. Wyvern soils are found along the northern edge of the Cobequids. These are similar in many ways to the Cobequid series. Significant areas of Wyvern soils were accessible to early settlers who cleared the land. Some of this is now reverting to forest while the rest is being used for blueberry production. Small areas of Hebert soils (well to excessively drained, gravelly sandy loams) are found on glaciofluvial sands and gravels around lakes.

VEGETATION

The plateau top of the Cobequids now supports a Sugar Maple, Yellow Birch and Beech forest (H.27) interlaced with coniferous species. Shallow soils on the plateau support Balsam Fir, Red and Black Spruce; the poorly drained depressions support Balsam Fir and Black Spruce (H.29).

The northern part of the plateau has the purest stands of hardwoods. Conifers become increasingly common to the south, especially Red Spruce and Balsam Fir. The influence of the Bay of Fundy can be seen towards the west where extensive stands of Red Spruce thrive up to 650 feet (200 m) above sea level. Parts of the plateau that were once cleared for agriculture are now blueberry fields. Other oldfields have come back in coniferous stands dominated by White Spruce.

Eastern Hemlock is common in ravines. White Spruce, Red Spruce and Balsam Fir form mixed woods with Sugar Maple, Yellow Birch and Red Maple on the slopes, becoming softwood forests of Black Spruce, White Spruce and White Pine in the valley bottoms.

Exposure to wind affects a large part of the unit. Red Spruce and Yellow Birch are particularly susceptible and may be stunted.

In 1912 C.D. Howe observed: "On the granite north of Advocate bay (there is) a luxuriant forest which contains 75 percent red spruce. The same type is found on the granite mass north of Greville bay. From there, the outcrops of this group of rocks occur only in small patches, until the Cobequid hills are reached, where they are found in largest mass. The northern slopes of the Cobequid hills in the neighborhood of Wentworth, for example, support at the base a mixed forest of hardwoods and red spruce, fir and hemlock, in which softwoods originally predominated. As one ascends the slopes the forest becomes prevailingly of the hardwood type. In some places it is two-thirds yellow birch; in other places it is about equally divided etween yellow birch, hard maple and beech. Near the top of the slopes one often finds narrow ridges which are covered to the extent of ninety percent with beech of inferior quality. In the higher levels frequently immense hopper-like basins are found nearly enclosed by ridges. In these, the forest is composed in nearly equal proportions of balsam fir, red spruce and the hardwoods. In the narrow valleys of the streams on the other hand, hemlock, spruce and fir prevail in the order named, so that looking at the northern slopes of Cobequid from a distance, one sees the green of the prevailing hardwoods interspsersed with black bands of coniferous softwood foliage."

Ground and shrub vegetation is usually varied and luxuriant. A number of unusual Arctic-alpine and Alleghenian plant species may be found in cool, moist ravines and in rich Sugar Maple woods.

FAUNA

The Cobequid Hills are a prime area for moose. The deep winter snows at higher elevations force deer to move to the lower slopes for winter concentration, thus reducing the opportunity for transferral of the central nervous system nematode parasite Parelaphostrongylus tenuis from the deer carriers to the moose. The mature hardwood forests support populations of various small mammals and birds. The erythristic (all-red) colour phase of the Eastern Redback Salamander is commonly found in the hardwood forest.

SITES OF SPECIAL INTEREST

- Road from highway 104 to Lornevale
  - shallow iron deposits 800 m north of Cobequid Fault.
- Londonderry
  - iron bearing carbonates formed the foundation of an iron industry in the 19th century.
- Folly Gap
  - U-shaped glaciated valley best seen near Wentworth.
- Folly Lake
  - glacial lake.
- Parrsboro Gap
  - glacial terraces, kames
- Economy River, Bass River, Moose River, Tatamagouche Mountain
  - falls
- Portapique River
  - cascades and gorge
- Nuttby Mountain
  - lookoff
- Bass River
  - Cobequid Fault zone of crushed rock
- Greville Bay and Cape Chignecto
  - cliff exposure of Cobequid Fault
- Provincial Parks and Park Reserves
  - Newville Lake

ASSOCIATED TOPICS

T12 Tertiary Drainage Patterns, T14 Deglaciation and Glacial Deposits.

ASSOCIATED HABITATS

H18 Oldfield , H27 Sugar Maple, Yellow Birch, Beech Forest, H29 Spruce, Fir Forest.

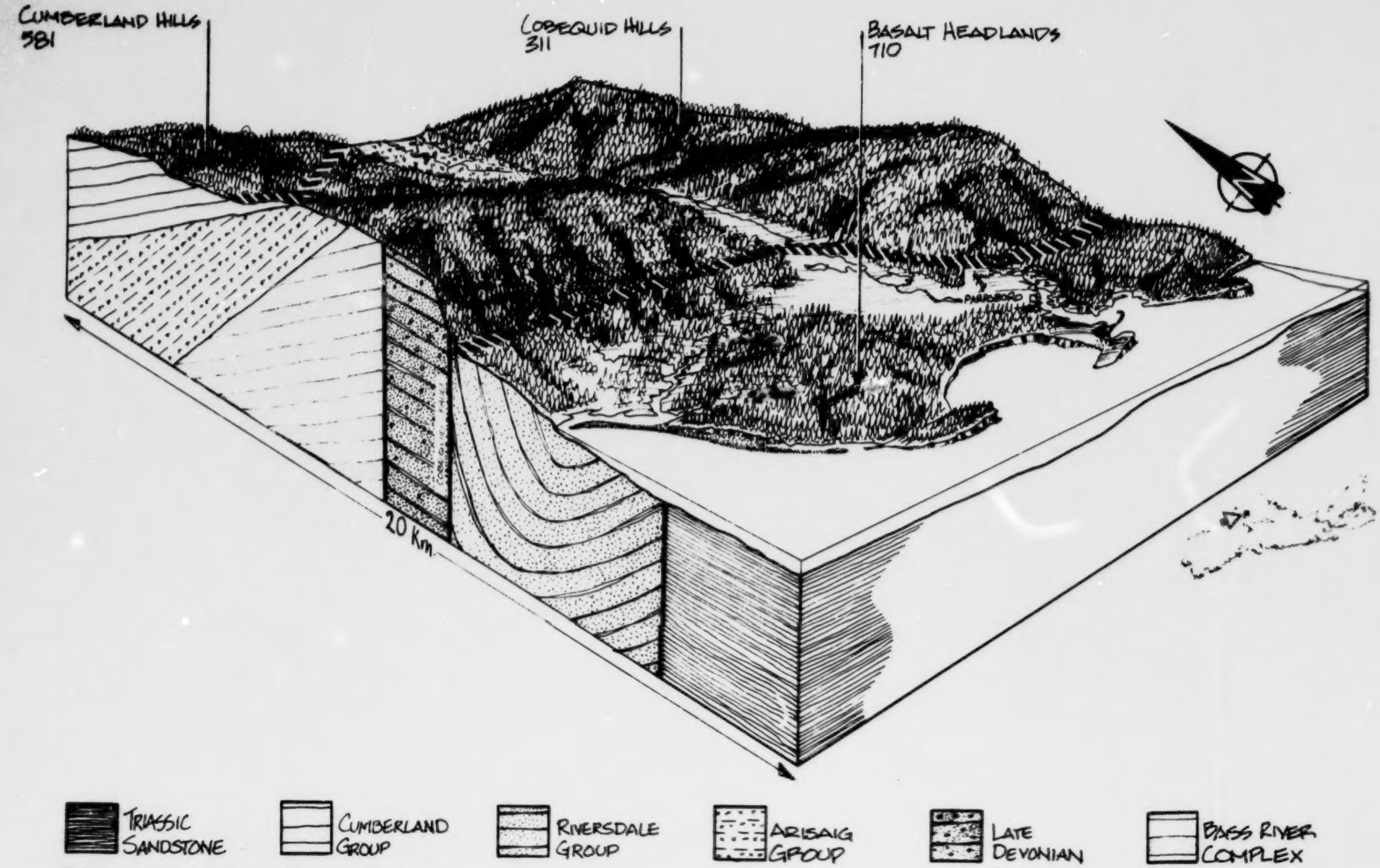

CUMBERLAND HILLS
581
COBEQUID HILLS
311
BASALT HEADLANDS
710
PARRSBORO
20 Km.
TRIASSIC SANDSTONE
CUMBERLAND GROUP
RIVERSDALE GROUP
ARISAIG GROUP
LATE DEVONIAN
BASS RIVER COMPLEX

Plate 2. Parrsboro Shore
The Cobequid Hills (311), part of the Avalon Uplands, descend abruptly along the Cobequid Fault to the lowlands fringing the Minas Basin. To the north, in contrast, the Cobequid Hills merge gradually into the Cumberland Hills (581). Headlands of basalt along the Minas Basin separate bays carved from the less resistant Riversdale shales and Triassic sandstones of the Fundy coast (710).

UNIT 312: PICTOU-ANTIGONISH HIGHLANDS

The Pictou-Antigonish Highlands are underlain by a block of old crustal rocks which are bounded and transsected by numerous faults. It stands at an average elevation of 800 feet (245 m) but is dissected into steep-sided hills and valleys where faults cut across the resistant massif. The two most important faults are the Hollow Fault in the northwest and the Cobequid-Chedabucto Fault on the south side. These two faults accommodated extensive lateral-slip motion as the crustal sections were slipping into place during the formation of Nova Scotia.

GEOLOGY

The strata within the Pictou-Antigonish fault block are dislocated and do not form a neat succession. However, when pieced together like a jig-saw puzzle, they provide an almost continuous record of the geological evolution of this section of Nova Scotia. This can be correlated with parts of Cape Breton, the Cobequid Hills and other areas further south along the Atlantic seaboard.

Early Geological Events

The oldest strata are the Precambrian Georgeville Group which consist of volcanic and sedimentary rocks, many thousands of feet thick. These are intruded by fine-grained igneous rocks which are believed to be the necks of ancient volcanoes. The Sugarloaf Hill south of Malignant Cove is an example of a volcanic neck. This early period of vulcanism ended with crustal disturbance and metamorphism which may have been part of the Taconic orogeny during the Ordovician.

Marine Sediments at Arisaig

Between the Taconic and Acadian Orogenies (Silurian to Devonian) came a period of continuous deposition in a shallow sea. During this time the Avalon Zone was developing far distant from the Meguma sediments which had already accumulated off the coast of Africa (or South America). The richly fossiliferous strata which accumulated in this shallow sea, are exposed north of Arisaig Point, and contain brachiopods, graptolites, pelecypods, trilobites, crinoids, cephalopods, ostracods and bryozoans. These fossils are well preserved and have been very significant in tracing the history of the Avalon Zone and relating it to other parts of eastern North America.

Freshwater Deposits

The succession of strata ended with the shallow accumulation of water deposits. The youngest are the red beds of the Knoydart formation (exposed along the road between McArras Brook and Dunmaglass, 3 miles (5 km) to the south). These contain the remains of fresh-water fish which have been correlated with similar strata in Europe. It appears that the North American and European crustal plates may have drifted together by this time, initiating the formation of Pangea and the onset of the Acadian Orogeny.

Acadian Orogeny

During the orogeny the pile of sediments was uplifted and granite was intruded. The Pictou-Antigonish block rose along the major fault lines and initially formed a topographic high. Later it became an island in the Carboniferous Sea and was eventually engulfed by Carboniferous sediments. Later on erosion caused readjustment to take place along the numerous fault lines which in turn produced a 'jumbling' of the strata.

GEOMORPHOLOGY

Faults

The northern border of the Pictou-Antigonish Highlands is the scarp of the Hollow Fault which extends from Cape George almost to New Glasgow. Beyond this to the west it joins the Cobequid-Chedabucto Fault. Along the Hollow Fault is a 650 feet (200 m) scarp which has developed as a result of differential erosion since the Tertiary. The old strata of the highlands are much more resistant to erosion than those surrounding them. The scarp is conspicuous south of Piedmont. Further northeast between Bailey's Brook and Doctors Brook the fault lies in a long straight valley which has a very high, steep southern margin. Along the valley flow the tributaries of several rivers which turn abruptly northwestwards and drain into the Northumberland Strait. The valley, called "The Hollow" or "Bruin's Highway" has eroded from the softer or broken strata within the fault zone. From Malignant Cove to Cape George, the Hollow Fault forms high cliffs along the straight coastline.

Within the body of the fault block many subsidiary faults cross cut in north-south and northeast-southwest directions. Narrow valleys have formed along some of these lines, particularly where softer strata have been downfaulted eg. east from Kenzieville. This valley was deepened during the Pleistocene and now contains deposits of sand and gravel which create a uniform grade. Some valleys are ancient landscape features, which are now being exhumed as the Carboniferous infilling strata are being stripped away. An example of such a fossil valley is found at Marshy Hope and along the Eden River. Another valley near Kenzieville lies along the length of the Kenzieville Trough - a downfolded section of the Arisaig Formation.

Around the borders of the Pictou-Antigonish Highlands the prominence of the scarp slope reflects the different hardnesses of adjacent strata. Where soft Windsor sediments are set against the resistant block the scarp is prominent, where harder Horton strata are juxtaposed the scarp has a diminished expression.

The southern boundary of the Highlands is the Cobequid-Chedabucto Fault; here the block is set against Horton strata. The topography of this margin is rugged. The scarp reaches 180 m in places and is cut by deep valleys where other fault lines create lines of weakness eg. along Garden River to Eden Lake, along Moose River, Beaver River and Campbells Brook. The height of the scarp in part reflects the vertical movement (in addition to the extensive horizontal movement) along this major fault.

Drainage

The drainage pattern is generally dendritic but is heavily influenced by fault lines. Along the margins, streams and rivers flow down the scarp slope in straight narrow channels. Unlike the Cobequid Hills there are no wind gaps across the Highland as evidence of superimposed drainage.

SOILS

Four major soil associations occur in this area. Cobequid soils occupy the southeastern sector of Pictou County. These are stony loams or sandy loam soils developed on a variety of tills derived from diorite, felsite, syenite and granite. Barney soils have developed on shaley loam tills derived principally from Silurian shales, while Kirkmount soils around North Bloomfield have developed on tills derived from schists, hard sandstones and slates. Well drained Thom soils have developed on tills derived from sandstone and hard metamorphic rocks.

Because of the elevation and low evapotranspiration, all these soils tend to have accumulated substantial levels of organic matter in the surface layers. Most are stoney and shallow to bedrock. The Barney series, is somewhat less stoney and is also somewhat finer textured than the others.

VEGETATION Mainly tolerant hardwood forest (H.27) covers this Unit, with Yellow Birch, Sugar Maple, and Beech being most common. Red Spruce, White Spruce, Hemlock and Balsam Fir are scattered on the upland surfaces and form coniferous stands (H.29) on the lower slopes and valley bottoms. Red Spruce is less common towards the eastern side of the Unit. White Spruce has colonized old farmlands in the area (H.26). As in Unit 311, the shrub layer is diverse and vigorous.

FAUNA This Unit provides a mixture of mature hardwood and softwood habitats and oldfields, with few bogs or lakes. Like the Cobequids, the Pictou-Antigonish Highlands have very good moose habitat. The fisher has been reported from this unit. Although little appears to be known about this area, it may be assumed that wildlife will be relatively abundant.

An historical perspective on the evolution of these forests is supplied by C.D. Howe writing in 1912; "This large mass of felsites and syenites ... supports a mixed, thoroughly culled forest. The eastern slopes along the Upper Ohio river are quite abrupt and are covered with a mixed coniferous and hardwood forest in which the hardwoods predominate. On some of the slopes they are in pure stands. The broad tableland between the headwaters of the Ohio river and Black brook is made up of low ridges and depressions, the former being covered chiefly by yellow birch and the latter by rather inferior red spruce. The soil is thin, and large areas are covered with rock fragments. The flats about the lakes, however, support nearly pure stands of good spruce. The tableland also contains frequent black spruce-fir swamps. The western third of the area is three-quarters hardwood, over half of which is yellow birch, and the remaining portion is about equally divided between red spruce and fir."

SITES OF SPECIAL INTEREST

- Sugarloaf Hill (south of Malignant Cove)
  - ancient volcanic neck.
- Arisaig Point westwards
  - well preserved fossils of brachiopods, graptolites, clams, trilobites, crinoids, cephalopods, ostracods, bryozoans.
- Knoydart
  - fossil fish, ostracods, plant remains in ancient coastal flood plain.
- Cape George to Malignant Cove
  - cliffs along the Hollow Fault.
- Marshy Hope, Eden River
  - fossil valleys with remnant Carboniferous infilling.
- Blue Mountain
  - good look-off north along French River
- Clydesdale (IBP Proposed Ecological Site 11)
  - mature, relatively undisturbed Sugar Maple forest.
- Provincial Parks and Park Reserves
  - Beaver Mountain
  - James River
  - Cape George

ASSOCIATED TOPICS

T4 Avalon and Meguma Zones, T12 Tertiary Drainage Patterns.

ASSOCIATED HABITATS

H18 Oldfield , H27 Sugar Maple, Yellow Birch, Beech Forest, H29 Spruce, Fir Forest.

UNIT 313: NORTH BRAS D'OR UPLANDS

GEOLOGY AND GEOMORPHOLOGY

The North Bras d'Or Uplands are a series of elongated northeast-southwest oriented fault blocks which are situated on the north side of Bras d'Or Lake. They are composed of Avalon crustal material, predominantly Precambrian in age which has risen in the landscape. The blocks have moved vertically along fault boundaries and have domed and tilted the surrounding Carboniferous strata.

The blocks occupy a central position along the tilted planation surface and generally achieve average elevations which are consistent with that position, about 800 - 1,000 feet (245-310 m). The elevations are greatest on the southeast side where movement was along faults. They then tilt towards the northwest, declining in elevation and ending in relatively shallow dip slopes on the northern margins.

The relief along the boundaries of the blocks depends upon the nature of the adjacent Carboniferous deposits. These Uplands existed as islands in the Carboniferous Sea and were probably at some time engulfed by sediment but have now been eroded out as topographic highs. Some parts of the margins are set against resistant early Carboniferous Horton grits whereas others lie against the very erodible Windsor Group deposits. The softer sediments are easily eroded and expose the resistant Precambrian rocks in maximum relief. Horton sandstones, on the other hand, form a resistant continuum and mask the boundary with the older rocks.

SOILS

A wide variety of metamorphic and granitic rocks occurs in this unit, but the strong Podzol development, and the presence of a thick iron humate B horizon typical of ferro-humic Podzols, tend to mask the diversity of the parent materials. The principal soil which has developed from the thin mantle of stony loam till is Thom, a well drained, stony, sandy loam. Small areas of peat are found in depressions. On the Boisdale Hills (313c) Mira soils (mottled sandy loam) have developed where drainage is impeded by relief. There are also some coarse textured Debert soils. Shallow soils occur on ridges and steep slopes.

VEGETATION Sugar Maple, Yellow Birch, Beech (H.27), and intolerant hardwoods (H.22) occupy the upper slopes and high ridges, while Balsam Fir, White Spruce and Black Spruce (H.29) cover the upland flats and ravine slopes. On the Boisdale Hills (313c) where elevations are somewhat lower 600 - 700 feet (200 m.) mixedwoods become more prevalent.

FAUNA There has been little direct study in this Unit, however, the small amount of information available for Unit 313(c) indicates that Unit 313 is not necessarily similar in terms of fauna to Units 311 and 312.

313a) CREIGNISH HILLS

GEOLOGY AND GEOMORPHOLOGY The Creignish Hills occupy the same relative position on the planation surface as the Pictou-Antigonish Highlands and achieve an average elevation of 900 feet (275 m). This block is divided into two almost equal sections of metamorphosed volcanic and sedimentary rocks; and granite; the former is Precambrian and the latter is Ordovician.

The northern margin is against Horton grits which form a rolling upland and mask the boundary in a topographic sense. The southern boundary is faulted from Whycocomagh Bay to River Denys Mountain, and forms a steep scarp slope against the adjacent Windsor Group deposits.

The Creignish Hills form a divide across western Cape Breton. Both the southflowing Inhabitants River and the northflowing Mabou River rise in these hills. The profile of the Upland as seen from near Port Hawkesbury is relatively even and dominates the first view of Cape Breton from the causeway.

313b) NORTH MOUNTAIN

GEOLOGY AND GEOMORPHOLOGY North Mountain lies on the west side of Bras d'Or Lake between Denys Basin and West Bay. It is about 850 feet (260 m) high and is composed of Precambrian granitic and George River Group rocks. The latter originally contained limestone bands which have been metamorphosed to marble. Some marble is still quarried at Marble Mountain.

The North Mountain block was situated outside of the early Carboniferous basin in which the Horton strata were deposited. Later on, during Windsor time, when the sea covered a wider area it became an island against which Windsor Group strata accumulated. The block is now almost entirely surrounded by Windsor deposits which are deeply eroded and give maximum relief on both the north and south sides. The scarp is steepest on the south side and forms cliffs along West Bay. The more gentle dip slope reaches Denys Basin at a shallower angle.

The block is crosscut by a fault which has formed a narrow steep sided valley. The valley is occupied by two streams, Kennedy's Brook and MacIntyre's Brook. Lakes, bogs and wandering streams are found on the relatively flat crest of North Mountain but once the marginal slopes are reached, the streams become straight and fast flowing.

313c) BOISDALE HILLS

GEOLOGY AND GEOMORPHOLOGY This part of the North Bras d'Or Upland lies on the east side of Bras d'Or Lake and has a more complex geological composition than either the Creignish Hills or North Mountain. The strata include late Precambrian sediments and volcanics, granites of Precambrian and Devonian age and younger volcanic and sedimentary rocks.

This Upland block is crosscut by northeast - southwest oriented faults which divide it into a series of strips. Precambrian granites and George River Group rocks are thus juxtaposed against Cambrian and middle Devonian strata. The fault lines are eroded to form scarp slopes in several places along the coast and inland. A well developed fault scarp can be seen in the Eskasoni Indian Reservation, another is aligned southwest and northeast along East Bay.

The Carboniferous strata immediately adjacent to the older rocks are the sandstones and shales of the Grantmire Formation. These are intermediate in erodability and provide moderate relief next to the harder upland strata.

FAUNA Of special note would be the large number of eagle nests in stream ravines. Deer use the side slopes for winter yards. The slopes shelter deer, especially on sunny days when they block winter winds. There are few to no moose in this area.

SITES OF SPECIAL INTEREST

Marble Mountain
- marble quarry.

Provincial Parks and Park Reserves
- Marble Mountain
- Barachois

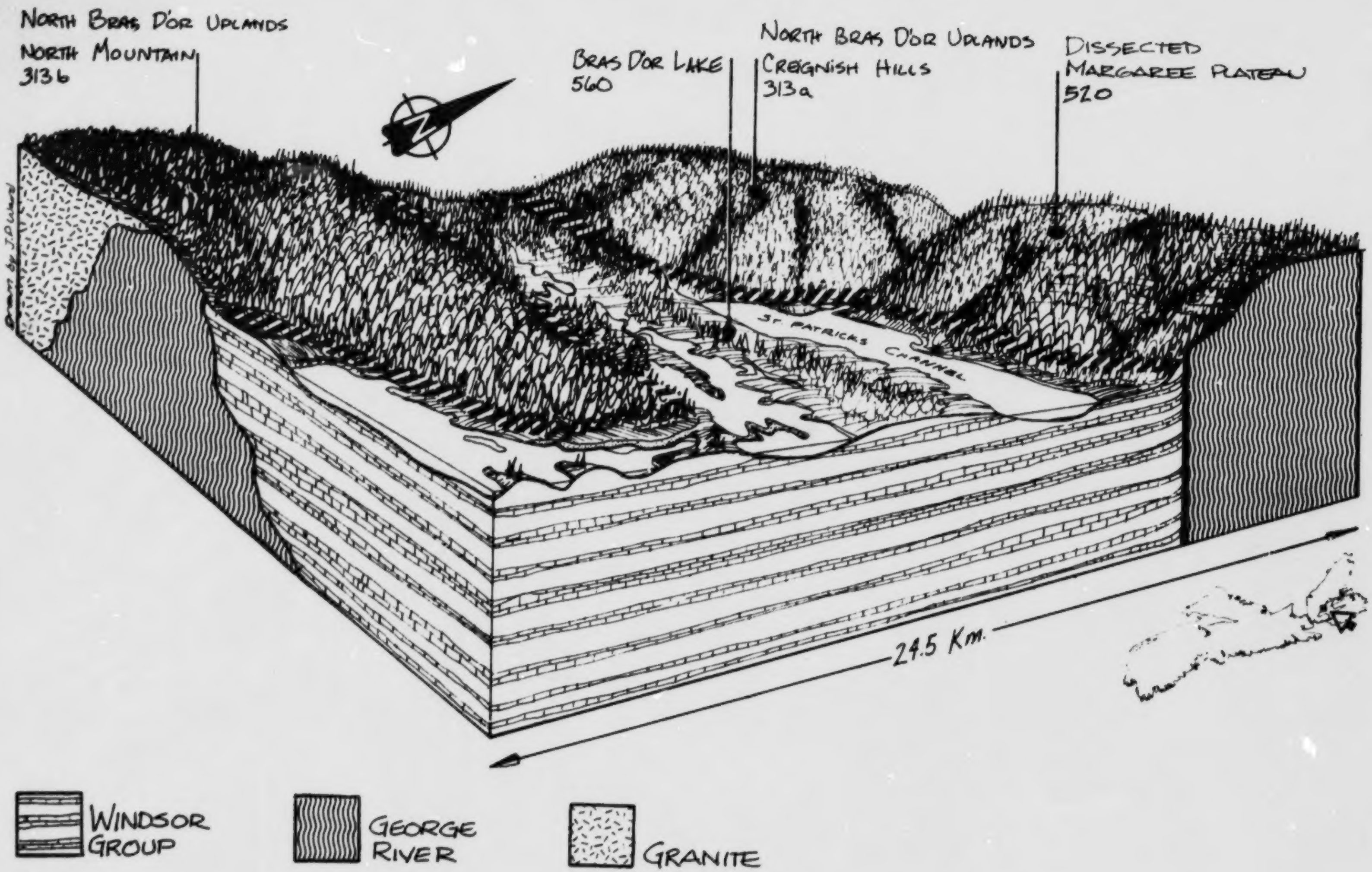

North Bras D'or Uplands
North Mountain
313b
Bras D'or Lake
560
North Bras D'or Uplands
Creignish Hills
313a
Dissected
Margaree Plateau
520
St. Patricks Channel
24.5 Km.
Windsor Group
George River
Granite

Plate 3. Bras d'Or Uplands
Fault bounded blocks of resistant metamorphic and granitic rocks form the North Bras d'Or Uplands (313). The easily eroded Windsor Group rocks remain only as a partly submerged lowland fringe around Bras d'Or Lake (560). More resistant Horton group sandstones remain as the dissected Margaree Plateau (591).

UNIT 314: MABOU HIGHLANDS

GEOLOGY AND GEOMORPHOLOGY The Mabou Highlands lie southwest of the Cape Breton Plateau on the Northumberland Strait. They form a rounded knoll 9 miles (15 km) by 5 miles (8 km) which reaches an elevation of 1,100 feet (335 m) at the north end and 1,050 feet (320 m) at the south end. The surface of the Highlands is highly dissected and little remains of the original plateau. The sides are deeply eroded. Streams which flow in wide valleys near the crest occupy deep gorges further down the slopes and are separated by rounded valley shoulders. The drainage exhibits an overall radial pattern with stream systems draining outwards from the rounded crest. The area is underlain by two rock types; one is a series of metamorphosed sedimentary and volcanic rocks and the other is a gneiss complex. Both are probably Precambrian in age and are comparable to similar rocks found in the Cape Breton Highlands (Regions 100 and 200). Both are very resistant to erosion. The western boundary of this block of Avalon crust is a north-south fault which has set Devonian/Carboniferous sandstones against the Precambrian strata.

The Highlands are almost entirely surrounded by Horton strata but unlike other sections of the Avalon Uplands they stand out in high relief against these rocks. At the boundaries the hills rapidly climb to 650 feet (200 m) above the Horton deposits. On the Northumberland Shore there are steep cliffs along the rather even coastline from Port Ban to Cape Mabou.

Coarse glacial deposits lie against the lower slopes of the Mabou Highlands south of Inverness. Other finer sandy deposits are found on the banks of Broad Cove, ascending to over 500 feet (150 m) above sea level.

SOILS The main soil series is Thom, a well drained, stoney, sandy loam. Thom soils are heavily podsolized, with a thick iron humate B horizon. Small areas of peat are common in depressions.

VEGETATION Away from the immediate influence of the winds off the Gulf of St. Lawrence, tolerant hardwoods (H.27) dominate the upland plateau in this unit, with Sugar Maple, Yellow Birch and Beech being the main species. White Spruce and Balsam Fir are found on coastal sites, while Balsam Fir, spruce and Hemlock form softwood stands or mixedwood stands with Red Maple and birch (H.24) on the lower slopes. A large area around South Cape Mountain has been cleared for use as a community pasture.

FAUNA

There is little information available on this unit, though the following has been reported: Trapping in the northern part of the Mabou Hills in July and September 1982 revealed that no Rock Voles or Gaspé Shrews were present but otherwise the small mammal fauna was diverse.

SITES OF SPECIAL INTEREST

Sight Point
- exposures of Precambrian intrusive rocks.

Inverness and Broad Cove
- raised beaches

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits.

ASSOCIATED HABITATS

H24 Spruce, Fir, Pine-Maple, Birch Forest, H27 Sugar Maple, Yellow Birch, Beech Forest.

320 Dissected Margins

GEOLOGY AND GEOMORPHOLOGY

At the margins of the Cobequid Hills and the Pictou - Antigonish Highlands in Pictou County are foothills which lie between the uplifted plateaux and the relatively undisturbed surrounding lowlands. The two main areas are a) Waughs River and b) French River.

320 a) Waugh's River

East of Warwick Mountain on the north side of the Cobequid Hills are a number of small faults which lie broadly parallel to the Cobequid Fault. These create a series of slices at the margin of the upland which form dissected steps down to the Northumberland Plain. Numerous rivers and streams create hill and valley topography which is attractive and varied. There are numerous viewpoints from the roads travelling down to Tatamagouche providing vistas of the slopes and plain beyond.

320 b) French River

The north and west margins of the Pictou - Antigonish Highlands are broken into numerous blocks by two sets of faults running north-south and east-west. Strata of varying hardness have been juxtaposed and the area has been dissected by many streams and rivers. The landscape is hilly with steep narrow valleys occupied by branches of French River.

SOILS

In both parts of this unit the soils reflect the contributions of both varied bedrock, and of Carboniferous glacial material brought in from the north.

320a Waughs River: Well drained Cobequid soils, derived mainly from granitic materials, occur on the higher elevations. In the Pictou County part of the sub-unit Westbrook soils (well-drained loam) have developed from a gravelly loam till which was derived from Carboniferous conglomerates of the Horton group. In Colchester County Wyvern soils, which are similar to Cobequid soils, have developed on granite rich tills.

320b French River: Thom and Cobequid soils (typical highland soils) again occur at higher elevations. Elsewhere Barney soils (well-drained loam) have developed on shaly clay loams derived from Silurian shales.

VEGETATION

Mixedwood forest covers most of this unit, with hardwood stands on well drained ridges. Balsam Fir, Red Spruce, White Spruce, Red Maple and birch (H.24) are the common species.

FAUNA

No information available.

SITES OF SPECIAL INTEREST

Fourmile Brook near Tatamagouche Mountain
- waterfall

Balmoral Mills
- picnic park and historic site (Grist Mill)

Provincial Parks and Park Reserves
- Wentworth

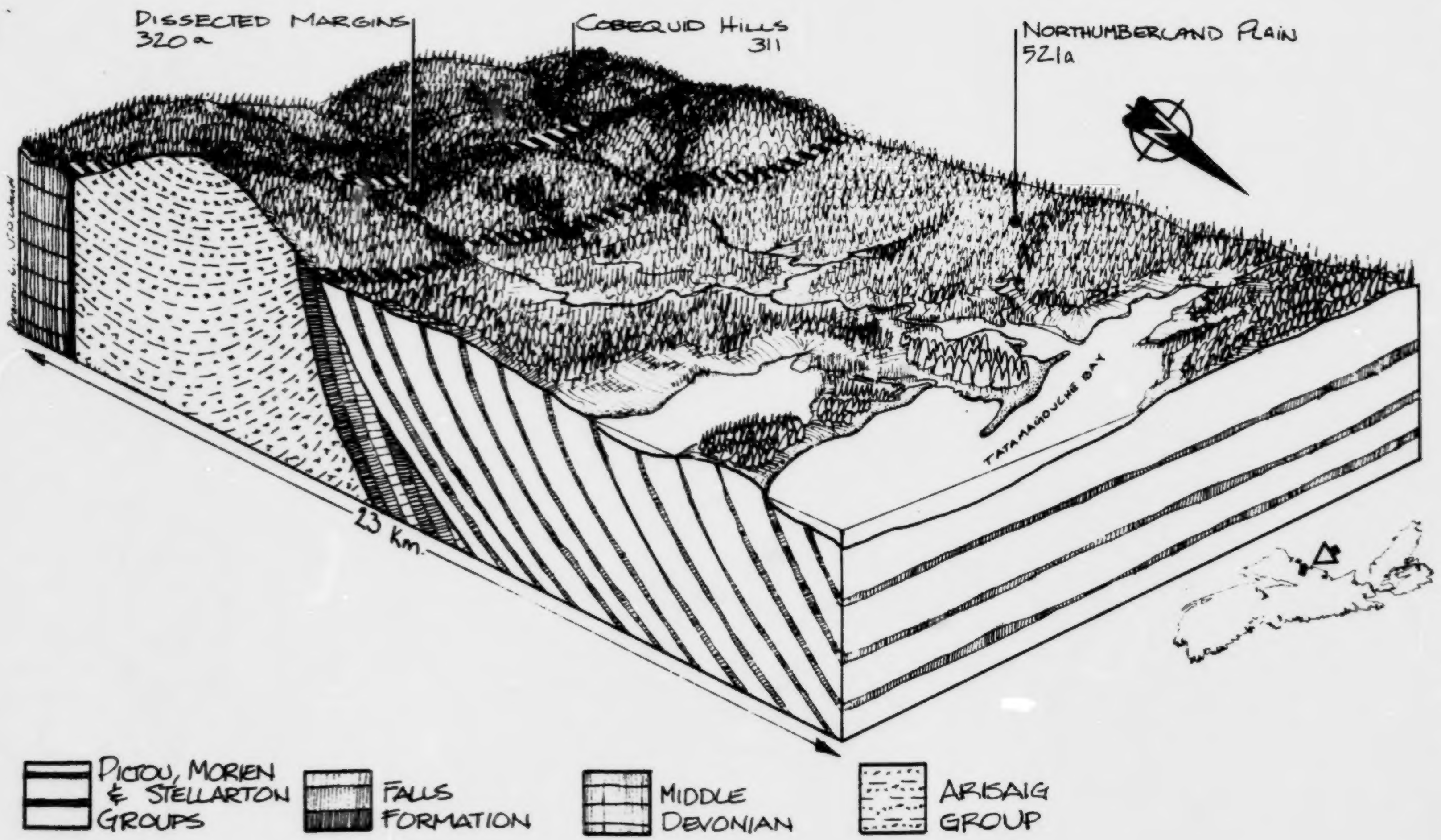

DISSECTED MARGINS
320a
COBEQUID HILLS
311
NORTHUMBERLAND PLAIN
521a
TATAMAGOUCHE BAY
23 Km.
PICTOU, MORIEN & STELLARTON GROUPS
FALLS FORMATION
MIDDLE DEVONIAN
ARISAIG GROUP

Plate 4. Northumberland Plain
The wide coastal plain (521) with low sandstone ridges nearly parallel to the coast is terminated abruptly by the Dissected Margins (320) of the Avalon Uplands underlain by older, more resistant sedimentary rocks. The Cobequid Hills (311) grade subtly into the foothills.

330 Fault Ridges

a) Sporting Mountain
b) East Bay Hills

GEOLOGY AND GEOMORPHOLOGY The South Bras d'Or Hills lie on the south side of West Bay, Cape Breton. The District is made up of two elongated blocks of Precambrian rocks, Sporting Mountain and East Bay Hills. Each block is composed of the same two rock types: volcanic deposits of the Fourchu Group (ash and lava interleaved with marine sediments), and granites, but in different proportions. Sporting Mountain is predominantly composed of granites whereas the East Bay Hills have more Fourchu Group rocks.

Both blocks are elongated northeast-southwest in accordance with the same prevailing trend of faults which dominates the geomorphology of the North Bras d'Or Uplands. The southeastern margins are also faulted, in this case bringing the resistant Precambrian strata against late Carboniferous sandstones and siltstones. On the northeastern side the contact is with easily eroded Carboniferous Windsor Group strata which were deposited directly against the blocks when they stood as islands in the Carboniferous Sea.

Morphologically the relief and elevation of Sporting Mountain and East Bay Hills reflect not only their geological setting surrounded by rocks of varying resistance but also their position on the low side of the planation surface. Both blocks rise to little more than 600 feet (180 m) forming low ridges in an otherwise lowland landscape. Precambrian rocks of equivalent resistance have created dominant uplands further north but here, where there was little uplift during the Tertiary, there was also minimal rejuvenation of erosional action and limited exposure of this hard core of old rocks.

The steepest slopes are found on the northwest side of both Sporting Mountain and East Bay Hills where soft Windsor Group rocks form a narrow band along the shore. The valley of Breac Brook, at the north end of East Bay Hills, appears to be an ancient coastal valley which was filled by Windsor Group deposits and is now being exhumed. The fault line on the southeastern margin can be seen in some areas, eg. northeast of Oban, but in general does not form a prominent scarp slope.

Both Sporting Mountain and East Bay Hills have relatively flat plateau-like crests which are poorly drained. The streams flowing towards West Bay become straight and fast flowing once the coastal slopes are reached but those flowing southeast retain a dendritic to deranged (or disorganized) pattern. In this part of Cape Breton south of Bras d'Or Lake glaciation more than geological structure appears to have influenced the drainage patterns. South of East Bay Hills the glacial direction is strongly northeast-southwest, in this case parallel to the fault which defines their southern boundary. This glacial direction can be clearly seen in the northeast alignment of the streams in the eastern part of this Unit.

SOILS

Heavily podsolized Thom soils with a thick iron humate B horizon cover most of this unit. They are associated with Arichat soils (poorly drained, mottled sandy loams) found where the relief is gently undulating or depressional. There are also small areas of peat.

VEGETATION

The two parts of this unit are somewhat lower than the North Bras d'Or Hills and tolerant hardwoods, although present, are no longer dominant. The South Bras d'Or Hills support instead mixed stands of Red Maple, White Birch, Yellow Birch, Beech, Balsam Fir and White Spruce (H.24).

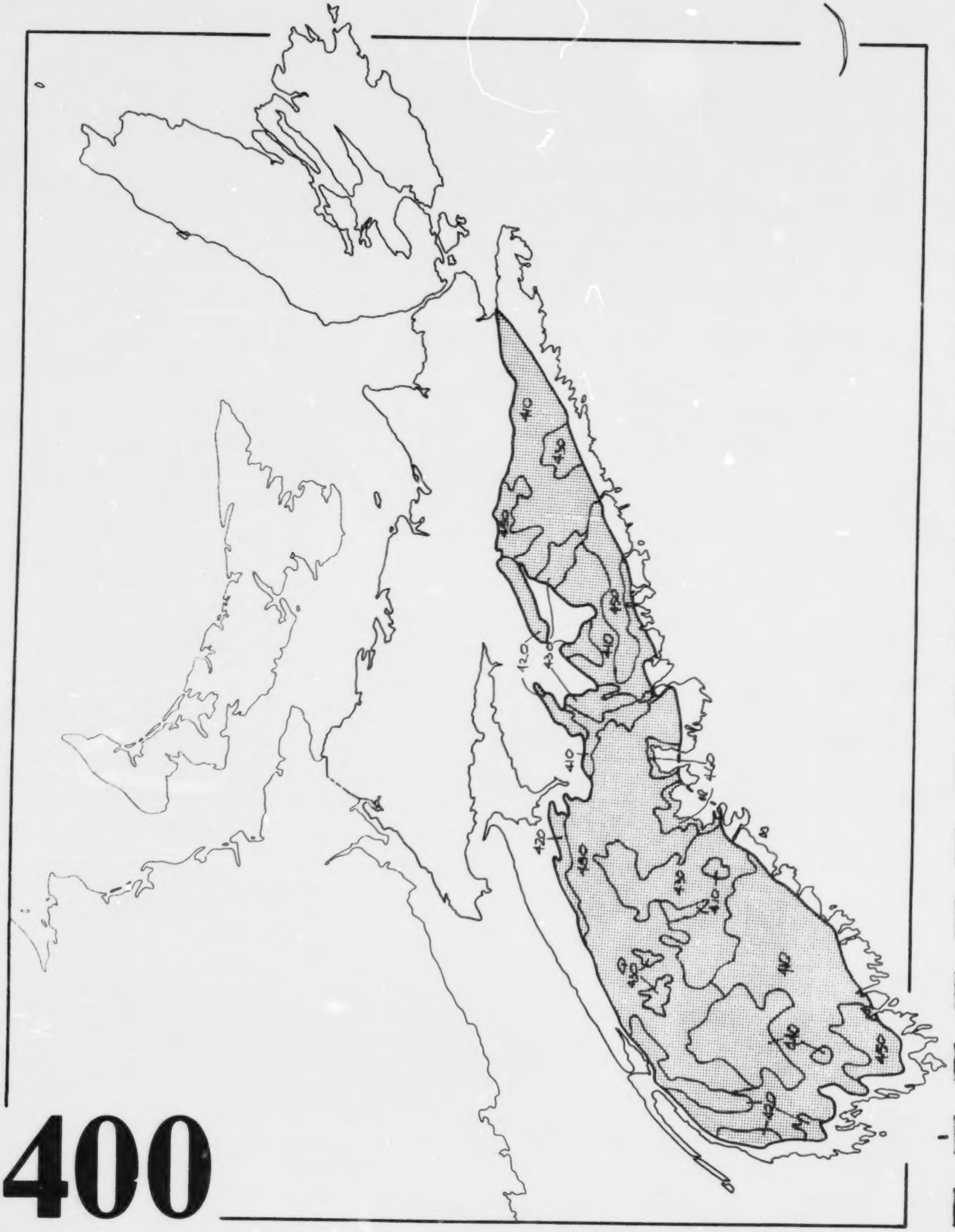
FAUNA

There are few moose in this area. Deer are found on side slopes in winter yards. There are a large number of eagle nests in stream ravines.

SITES OF SPECIAL INTEREST

Irish Cove Park (East Bay Hills)
- view of East Bay and road cut exposure of Precambrian ash (tuff) deposits. The scarcity of detailed information on this District has allowed no further identification of sites of interest.

Provincial Parks and Park Reserves
- Ben Eoin
- Big Pond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400 ATLANTIC INTERIOR

REGIONAL CHARACTERIZATION

Inland of the coastal forest the immediate climatic influence of the Atlantic Ocean is replaced by slightly warmer summers and cooler winters with much less wind exposure. On the planed surface of the old, hard rocks, which is tilted gently to the southeast, flow some of Nova Scotia's longest rivers. Most of the province's lakes have been created by glacial action on this relatively flat surface. Vegetation varies from mature spruce-hemlock-pine forests common on the Kejimkujik drumlins (433) to the heath vegetation on the granite barrens (440).

GEOLOGY

In the Atlantic Interior there are three main groups of rocks: slate, greywacke (the Meguma Group), larvas and ash (the White Rock Formation), and granite.

The Meguma Group

The rocks of the Meguma Group are Cambrian to Silurian in age. It has been divided into two units, the Goldenville Formation after a mining area in eastern Nova Scotia where the strata are well exposed, and the Halifax Formation. The Goldenville Formation is made up of greywacke (a quartz-rich rock containing some clay), and the Halifax Formation is made up of slates.

The strata of the Meguma Group are widely exposed across the Region and underlie about half of the terrain. They were deposited in an extensive offshore basin in which conditions stayed the same over wide areas and for long time intervals, consequently they are rather uniform in colour and texture wherever they are found.

Within the Meguma gold deposits have formed on domes and plunging anticlines where the strata became fractured by the folding. The richest veins usually occur in the zone of maximum curvature, with the largest veins in tightly folded anticlines. The veins were apparently deposited from solutions arising deep within the lower areas, which penetrated up through the fractures and along the bedding planes.

The total thickness of the Meguma Group is unknown because its base cannot be seen and its top has been eroded away. A section of Goldenville about 1,900 feet (5,650 m) thick was measured by Taylor between Sissiboo Falls and Weymouth; this appears to be close to the maximum presently exposed. Similar thicknesses have been indicated in eastern Nova Scotia. About 12,000 feet (3,650 m) of the Halifax Formation are known to have been deposited; perhaps much more in the vicinity of Halifax. This thickness thins out to a maximum of 4,000 feet (1,225 m) or less in southwestern Nova Scotia.

The White Rock Formation

In the Silurian, following the deposition of the Meguma Group one or more volcanic centres developed - probably close to what is now the coastal area near Yarmouth. A series of strata built up comprised of larvas and ash (about 50%), sandstone and mudstone (50%). These are jointly called the White Rock Formation. They are preserved in a series of synclines in the Yarmouth area, at Cape St. Mary, along the Sissibou River, at Bear River and in the Gaspereau area. The White Rock Formation is thickest at Yarmouth where 10,000 feet (3,000 m) have been measured with only the bottom exposed, and becomes progressively thinner to the north.

During the Late Silurian to Early Devonian period the Meguma and White Rock strata were folded and metamorphosed (changed by heat and pressure) during the crustal disturbance called the Acadian Orogeny. The strata folded much as a rug would be if its edges were pushed together. For the most part the axes of the folds lie parallel to the long axis of the province and form an arc from Yarmouth to Canso. They lie an average of three miles (5 km) apart and can be traced lengthwise for up to 90 miles (150 km). The folds are sometimes symmetrical but are often asymmetrical and often so tight that the crests have turned sideways and have become overturned.

While the lateral pressure was exerted the temperature was raised to a maximum of 1200°F (650°C) and the character of the original strata was changed. Under these conditions the chemical elements of which the rocks are composed recombine to form a characteristic series of minerals: garnet, staurolite, andalusite and sillimanite. This process is called Regional metamorphism. The temperature and pressure conditions of the metamorphism can be bracketed by examining the minerals which formed, each of which only forms when certain conditions of temperature and pressure exist.

Soil surveys carried out in the 1950s and 1960s reported soils developed from mica and hornblende schists, particularly in Yarmouth and Digby Counties. Correlation of these soils with the geology is unclear as zones of intense metamorphism of the quartzites are as frequent in unit 412 as in unit 411.

Granite

The third main group of rocks in the Atlantic Interior fall under the name granite. This familiar coarse-textured rock actually includes a whole range of related but different rock types. They have a variety of colours, textures and compositions but commonly contain large greyish or pink crystals of potash feldspar in a matrix of smaller crystals dominated by quartz and mica.

Most of the granite lies in a huge body called the South Mountain Batholith which is exposed in a giant arc from Yarmouth county northwards to the edge of the Annapolis Valley and around to Halifax. It was intruded during the late stages of the Acadian Orogeny as a hot, thick liquid (magma). The magma rose by penetrating the overlying Meguma strata, breaking off blocks and assimilating them. In places near the contact, blocks of Meguma country rock can be seen in various stages of assimilation. In some places they look almost unchanged whereas in others they have been almost entirely absorbed and can only be seen as ghosts. These blocks are called Xenoliths.

The heat given off during the process of intrusion and later as the magma cooled, baked the surrounding Meguma strata and created a narrow contact aureole. In this aureole characteristic minerals have developed, in particular cordierite which is round and black and gives the slates a spotted appearance. A good example of the changes which take place close to the contact can be seen west and north of the Northwest Arm near Halifax.

Pre-Carboniferous Erosion

Following the Acadian Orogeny and emplacement of the granite there was a period of very rapid erosion. Several miles thickness of material was removed within about ten million years and the granite was exposed. The sediments which were generated during this erosion were carried off and deposited elsewhere. The erosion surface, still being actively worn down, was later to form the basement on which Carboniferous strata were deposited.

Development of the Present Topography

Probably during the Cretaceous the whole area was eroded down to a fairly level surface which is now more or less coincident with the overal level of the Atlantic Upland. Large areas of granite became exposed some of which now form domes or high rounded hills. The overlying, folded greywacke and slates were eroded away and now exist mainly around the edges of the granite, or in what were the lower areas between the granite cupolas and domes. The slates being the uppermost strata, were worn away when the Meguma folds were planed off and the greywacke was exposed underneath. The slates are still preserved in many places in the synclinal troughs and now occur as long, narrow bands running east and west. The folds are steeper and more compressed east of Halifax than they are to the west, so that the slates between Halifax and central Guysborough County are in rather narrow bands, while northward in Hants County they form wide zones. The general pattern can be seen on the geological maps. It is only in western Lunenburg County, and in adjacent Queens and Annapolis counties, that large areas of slate are found.

Faults

The topography in southwestern Nova Scotia has not been influenced significantly by faults. However east of Halifax, where there are many faults and the strata are also more intensely folded, the opposite is true. From St. Margarets Bay to Guysborough, the Meguma strata are shattered by innumerable faults, a number of which affect the outline of the coast and the topography inland. One at Cole Harbour continues inland up the valley of Lake Major; another at

Sheet Harbour controls the upper bend of the harbour, continues up the deep valley of the West River, and stretches inland practically across the entire Southern Upland. The long, straight harbours at Indian Harbour, Country Harbour and New Harbour in eastern Guysborough County are also determined by faults, with the one at Country Harbour being the most prominent. There, the deep, straight-sided channel penetrates inland about 15 miles (25 km) to form one of the best natural harbours in the world.

Topography

When viewed from North Mountain across the Annapolis Valley, or from an elevation looking south towards the escarpment of Guysborough County, the surface of the Atlantic Upland presents an almost even, level skyline. This uniform surface is also evident inland, as in northern Annapolis County. There the upland surface is around 500 feet (150 m) above sea level and has a relief of barely 50 feet (15 m). East of Halifax, near the coast, the river valleys are deep and cut far below the surface, but even here the uniform height of the upland surface is evident from a distance. In the southwest there is very little relief, and the land is either almost flat over large areas or has only low ridges and wide, shallow valleys.

This upland surface slopes southeast or directly towards the Atlantic coast, but there is also a distinct lowering of the elevation, and more uniform topography southwestward towards the Gulf of Maine. This is particularly evident from Queens County to Yarmouth, where broad expanses of peat bog are present and many of the streams are slow-flowing and interrupted by shallow, rocky ponds and lakes. The highest elevation is near the northern border of the Region where the divide between the streams draining north and those flowing south makes a great arc from near Pubnico, north almost to the slope of the Annapolis Valley and around to the Waverley Lakes near Halifax.

The highest points along this northern border are rounded hills rising gently from the surrounding country. Two granite knolls south of Kentville are typical: one of them, north of Lake George, rises to over 900 feet (275 m) and another, southwest of Gaspereau, is around 850 feet (260 m). Several slate hills in the same general area are only slightly lower, being nearly 800 feet (245 m) high. In northern Annapolis County the highest area, southwest of Bridgetown, is a little over 900 feet (275 m) high and from there the surface slopes gently down to Brier Island. In eastern Guysborough, along the northern edge of the narrow band of upland, the elevation is about 750 feet (225 m) above sea level. Only occasionally throughout the upland does a hill rise significantly above the surrounding area. One of these is Aspotogan Mountain on the peninsula east of Chester, which reaches a height of 475 feet (145 m) in an area with an average elevation of barely 250 (75 m) above sea level.

Granite Area Granite covers the most extensive areas of the Atlantic Interior and reaches the highest elevations. The rock is massive and seems resistant to chemical change, although postglacial weathering has affected all exposed surfaces. Low rounded hills or shapeless ridges rise, as a rule, less than 65 feet (20 m) above the mean elevation, with broad, shallow depressions intervening which are too irregular to be valley-like. High knolls may occur occasionally, but everywhere the slopes are rounded and subdued with no particular pattern or design. The drainage is poor, and sluggish rivers or streams wind aimlessly from one shallow lake to another. Large boulders line their channels, and the lakes are dotted with boulders.

Greywacke Area The greywacke topography is somewhat more varied. In eastern Nova Scotia, on the northern border of Halifax and Guysborough counties, the surface is much like a plateau with long, low ridges running east and west. Large angular blocks of greywacke cover the ground and the soil is usually thin and acid. The intervening hollows are swampy and have their long axes generally oriented parallel to the strike of the strata. The drainage is impeded by deposits of glacial drift. The river channels in the interior are shallow because the streams run down the tilted erosion plain across the fold axes, and cut across the layers of resistant strata. Near the Atlantic coast the topography is frequently more uneven and the stream channels are deeper, but even here the land tends to be monotonous, its surface covered with scattered rocks of all sizes. Greywacke is also common in southwestern Nova Scotia and again the topography tends to be flat and monotonous. Chains of lakes, streams and stillwaters occur in the interior, with low ridges following the trend of the underlying strata. In Queens and Shelburne counties, the rivers and streams tend to cut across bands of harder rock to form rapids and low waterfalls, as along the Medway and Mersey rivers. In Yarmouth County, the folds of the strata bend southward, and consequently the flow of the streams is along the strike of the structures rather than across them. The streams flow slowly through wide, shallow valleys, where lakes and stillwaters occur. In parts of Shelburne County, the land is practically flat as far as the eye can see, as if it had been planed off to a level surface to form broad expanses of poorly drained areas and bogs.

Slate areas and drumlins

The slate areas present a more interesting and varied topography than do the areas of greywacke and granite. Slates are weathered relatively easily. The surface of the slate areas has been planed off, and the resultant loose material has been carried away to form a deep glacial drift with a high percentage of silt and clay. The advancing glacier moved over the area like a bulldozer, scraped off the weathered material, carried it for a kilometre or so and then, overloaded by the mass of material, dropped it and sometimes shaped it into drumlins.

Where there is sufficient material, the formation of drumlins produces a rolling topography. The drumlins may be isolated; they may overlap to form irregular hills; or they may be joined to make beaded ridges. The slate areas of Lunenburg County form typical drumlin country, a very distinctive type of topography which can be recognized as soon as one enters it. The small, oval hills are scattered over the landscape, generally with ponds or lakes situated in the hollows between them. On land they appear as swarms which are often quite well defined geographically.

CLIMATE

The Atlantic Interior is a large, contiguous region, which includes considerable climatic variation, but has basically an inland lowland climatic regime, sheltered from direct marine influences. The regime is characterized by cold winters and warm summers. Variations in temperature and precipitation are, to a certain extent, governed both by distance from the Atlantic coast and by the degree of latitude north.

The mean annual temperature range varies from 34°F (19°C) towards the southwest tip of the province to 42°F (23°C) and higher in the more inland areas. In most of the region January mean temperatures are below 23°F (-5°C), though generally warmer towards the coast. Mean temperatures rise above freezing by the end of March, with spring arriving somewhat earlier in the southwest. By July most of the region has warmed to a mean temperature in excess of 63.5°F (17.5°C), except in the more northerly areas of the Region in Halifax County and Guysborough County. The area around the LaHave drainage basin and Kejimkujik Lake tends to warm up earlier and to have hotter summer temperatures. Freezing temperatures return to the region by the second week in December, and a little later near the southwest tip.

The mean total annual precipitation ranges between 48 and 64 inches (1,200 and 1,600 mm). The drier areas are found near the southwestern tip and towards the interior. Mean total snowfall ranges from 60 inches (150 cm) near the coast to 100 inches (250 cm) or more further inland and in higher areas. The snow cover season varies from about 110 days in the southwest to greater than 130 days further north.

The frostfree period varies from less than 100 days in the interior to over 140 days in the southwest. The number of accumulated growing degree days are highest in the southern part of the region, tapering off towards the north.

SOILS

The major factors affecting soil development in this region are the resistant character of the granite and quartzite bedrock, the undulating and often poorly drained terrain, and the influence of finer textured tills transported by glacial action from Carboniferous areas. Over most of the region strong scouring has left a thin bouldery till cover, on which humo-ferric podzols predominate, with considerable areas of gleysol, rockland and peat. Coarse, bouldery sandy loams have formed in granitic areas, while on quartzite the stoney, sandy loams have slightly finer textures. Where soils developed from slates and schists occur vigorous vegetative growth is prevalent in marked contrast to the quartzite soils. The soils themselves are usually very permeable, but drainage is often impeded by topography or the underlying bedrock. Soils are strongly leached and very acid. An important feature of the soils of this region are the drumlin fields. Soils formed on drumlins are often better drained, finer textured, deeper, and somewhat more fertile.

VEGETATION

The Atlantic Interior covers three of Loucks' forest zones. The largest area falls within the predominantly softwood Red Spruce-Hemlock-Pine zone. The LaHave basin, between Kejimkujik Lake and the LaHave River, is in the Sugar Maple-Hemlock-Pine zone. The hilly areas around the Musquodoboit River fall within the Sugar Maple-Yellow Birch-Fir Zone.

The main influences on the regional vegetation are the inland climate with its warm summers, the sandy acid soils, the mixed drainage, and extensive disturbance by fire and logging. Softwoods are dominant but intolerant hardwoods frequently occur on burnt-over land, while pockets of tolerant hardwoods are found on higher, better drained sites. Red Spruce and Hemlock were once abundant throughout much of the Region, although both have been depleted by cutting.

In the southern part of the Region (south and west of a line from Windsor to Halifax) where the soils are generally better drained, and summer temperatures are slightly higher, spruce and Hemlock are found in association with Red Oak and White Pine. Balsam Fir and Red Maple are found on disturbed sites but the fir usually disappears within thirty years. The vigorous regeneration of Balsam Fir has led to the establishment of the Christmas tree industry, centered in district 430. Beech was once abundant, but is now found mostly on drier ridges. Ash is found on seepage slopes throughout, particularly on the sides of drumlins. Bogs and swamps are very common, particularly towards the southwest tip of the Region.

In the more northerly part, north and east of a line from Windsor to Halifax, where summer temperatures are slightly cooler, and the drainage poorer, Red Spruce and Hemlock are found with Black Spruce and Balsam Fir. Sugar Maple and White Pine are found on rolling hills particularly inland. Black Spruce swamps and peat bogs are extensive, and Red Maple, Aspen and Wire Birch predominate as post-fire species rather than Red Oak. On the rolling hills around the Musquodoboit Valley higher elevations and better drainage favour tolerant hardwoods and mixed woods.

Botanically, the southern part of this region is distinguished by the presence of the "Southwestern Flora" - a group of plants with more southerly associations, now isolated from their range further south.

FAUNA

Softwood and mixed wood forest habitats predominate in this region, favouring fauna of a more boreal association. Disturbance is widespread and there are very few areas of mature forest. New growth on recently cut-over or burnt areas provides good forage for ungulates. Small pockets of agricultural land are scattered through the region, often in association with drumlins. Bogs and inland barrens are common. Small mammal diversity is low to moderately high depending upon habitat. Two species, the White-footed Mouse and Southern Flying Squirrel, are disjunct in Nova Scotia from other North American populations. The Southern Flying Squirrel has a restricted distribution (Kejimkujik Park) but the White-footed Mouse distribution coincides with the boundaries of the Region. Lakes and streams cover a considerable proportion of the region, but the very acid and deeply coloured character of the water supports an impoverished freshwater fauna.

The Atlantic Interior is divided into six districts on the basis of morphology, surficial deposits and vegetation characteristics. These are:

410	Quartzite Plains
420	Slopes and Ridges
430	Drumlins
440	Granite Barrens
450	Granite
460	Bays

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and the North Atlantic Ocean, T4 The Avalon and Meguma Zones, T5 Granite in Nova Scotia, T10 Land-based Economic Deposits, T11 Development of the Ancient Landscape, T13 Glaciation, T16 Colonization by Plants, T20 Nova Scotia's Climate, T29 General Hydrology, T30 Water Quality, T33 Soil Distribution, T42 Trees, T43 Plant Communities in Nova Scotia, T45 Successional Trends in Vegetation, T59 Land and Freshwater Invertebrates, T60 Freshwater fishes.

ASSOCIATED HABITATS

H11 to H16 Freshwater Habitats, H17 Barren, H22 Maple, Oak, Birch Forest, H25 Spruce, Hemlock, Pine Forest, H28 Pine Forest, H34 Flood Plain Forest.

410 Quartzite Plains

GEOLOGY AND GEOMORPHOLOGY District 410 is underlain predominantly by resistant metamorphic rocks - greywacke and schist. It lies on the lowest part of the tilted planation surface so consequently the elevations are low and there is little relief. The lowest part of the area is in the southwest where elevations rarely exceed 350 feet (100 m) and average 150 feet (50 m). In the southeast the average is nearer 350 feet (100 m) with the highest elevations around 500 feet (150 m).

The bedrock is blanketed and obscured by a thin sandy till but is exposed locally where the surface has been scraped clean. Beneath the till, the eroded folded strata produce a topography of low parallel ridges separated by shallow valleys.

The drainage is controlled by glacial lineations and deposits, and the pattern that develops reflects the angle between the fold structures and the glacial direction. In the west they are parallel to one another while in the east they are at right angles.

The following description, made by C.D. Howe in 1912, applies to soils in areas where only local quartzite materials are available. It is most relevant to areas in Halifax and Guysborough Counties (Unit 413) but also applies to some southern areas of unit 412 in Queens, Shelburne and Yarmouth Counties: "(Quartzite), composed entirely of quartz and mica, when decomposed, yields about as much plant food material as glass. Moreover, the quartzite soils, unless increased by ice- or water-deposited materials, are naturally thin, often not over two inches deep. They support an abundant growth of heath plants, like the blueberries and laurel, whose leaves in decomposing make a sour soil. The fact that usually these quartzite soils are ill-drained adds to the acidity of the soil. In a sour condition, the vegetable matter does not decay normally but accumulates in a peaty mass called raw humus. A sour soil is no more favourable to the growth of trees than to the ordinary farm crops. While the quartzite areas have been extensively burned and are now semi-barren or barren, it is probable that this is not far removed from their original condition. At all events is may be reasonably inferred that they never supported forest trees larger than those of pole-wood size, ..."

SOILS

Where the soils have not been burned, especially near Lake Rossignol (unit 412), organic matter in the soil profile provides good forest growing conditions. Where repeated burning has occured, organic matter is depleted and slow to rebuild. This is the situation in the rest of unit 412 and throughout much of unit 413. Greater proportions of fine materials in the soils derived from schists in unit 411 provide good forest growth.

Within the district three units are distinguished on the basis of surficial deposits:

411	Southwest Schists
412	Mersey Meadows
413	Quartzite Barrens

UNIT 411: SOUTHWEST SCHISTS

GEOLOGY AND GEOMORPHOLOGY

Unit 411 covers an area in southwestern Nova Scotia which is southwest and west of the South Mountain Granite. The bedrock is dominated by greywacke with bands of mica and hornblende schists, which is interfolded with slate in the central part of the area. As suggested in the Regional description, the occurence of schists and the soils developed from them is not clearly documented.

The present landscape, morphology and drainage reflects several phases of glacial deposition. These are considered in more detail in Unit 421. The low lying bedrock has been covered and its relief obscured by glacial deposits, although, in places, a system of west and southward trending valleys can be seen. The present drainage has been glacially imprinted and is to the south.

The surface deposits are of quartzite and schist tills with numerous low drumlins, 6 to 65 feet (2 - 20 m) high. Drumlins on the quartzite are lower and less frequent than on the schists. Drainage is through a deranged pattern of sluggish streams and, since the drumlins create additional impoundments, numerous lakes are scattered across the surface.

There are a few small eskers south and east of Wentworth Lake in the centre of the unit but generally the most interesting glacial deposits are along the shores of St. Mary's Bay where outwash deposits, raised beaches and deltas, usually less than 15 feet (5 m) deep, are found. These are considered in detail, in the description of District 820 (Atlantic Coast; Cliffs and Beaches).

SOILS

The soils in this unit are derived mostly from quartzite and schist and are, with the exception of scattered drumlinoid features, generally shallow and stony sandy loams. The major soils derived from quartzite series are well-drained Halifax and imperfectly drained Danesville, with small areas of poorly drained Aspotogan soil and peat. The schists have developed Yarmouth, Mersey, Liverpool, Deerfield and Pitman soils. Soil drainage patterns are very complex and are reflected in the varied vegetative cover.

This unit falls within the Wentworth Lake District of Louck's Red Spruce-Hemlock-Pine Zone. Deeper soils on the tops of drumlins, derived from schists, support the tolerant hardwoods; Sugar Maple, Yellow Birch, Beech with Red Oak, and some intolerant hardwoods. More Red Spruce, Hemlock, and Pine occur on the lower slopes with intolerant hardwoods and Aspen.

Swamp stands are composed of Black Spruce, Balsam Fir, Larch, and, in certain localized areas, White Cedar. Swamps of Red Maple and Black Ash are also a common feature. In old fields Red Spruce, White Spruce and Balsam Fir are the colonizers with White Pine invading old fields and pastures on coarser soils.

Coastal plain plants are found on lake margins, in meadows and bogs. They are most common in the Tusket Valley include some rare species such as Pink Coreopsis.

FAUNA

This unit provides moderately good wildlife habitat, particularly for wintering Bald Eagles, migratory Woodcock (fall), Snowshoe Hare and Bobcat. The Acadian Whitefish is found in this area. The Tusket River supports an important Gaspereaux fishery, and also provides habitat for a diversity of freshwater molluscs and arthropods, some with coastal plain affinities.

SITES OF SPECIAL INTEREST

Hectanooga (IBP Proposed Ecological Site 54)
- largest known stand of White Cedar in Nova Scotia.

Belliveau Lake (IBP Proposed Ecological Site 57)
- spring-fed lake with diverse aquatic plant communities, only known locality for Clethra alnifolia.

Provincial Parks and Park Reserves
- Ogden Lake

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T15 Post-glacial Climatic Change, T54 Mammals.

ASSOCIATED HABITATS

H11 Freshwater Lake, H12 Slow-moving Stream, H14 Blanket and Raised Bog, H16 Swamp, H25 Spruce, Hemlock, Pine Forest, H27 Sugar-Maple, Yellow Birch, Beech Forest.

UNIT 412: MERSEY MEADOWS

GEOLOGY AND GEOMORPHOLOGY Unit 412 is divided geographically into three areas with similar features. These are:

a) Lake Rossignol
b) Leipsigate Lake
c) Rocky Lake

These three areas are blanketed with quartzite till but have only a few scattered drumlins of the same material. The area also has a number of lakes but drainage is relatively unimpeded and the rivers form dendritic patterns. Here the rivers flow perpendicular to the bands of interfolded quartzite and shale sometimes forming small waterfalls where resistant quartzite ridges are encountered.

Glacial outwash deposits and ice contact drift (such as collects in crevasses) are found in the upper reaches of Argyle River. Eskers are common in many river valleys but particularly those of the Argyle, Jordan and Sable Rivers (412a).

SOILS (412a - Lake Rossignol)
Moderately coarse textured soils developed from schistose parent materials include large areas of well-drained Mersey, and imperfectly drained, mottled Liverpool soils. Towards the coast imperfectly drained Danesville soils are common, while inland there are large areas of well drained Halifax and Gibraltar gravelly sandy loams. Around Greenfield there is a large area of well-drained Bridgewater sandy loam. A feature of this unit is the substantial acreage of barrens, some of it caused by repeated burning, but some underlain by a dense ortstein layer. The effects of repeated burning have been profound for these soils. A band of heavily burned forest extends from Argyle Municipality eastwards to the Broad River in Queens County. Organic matter loss to the fires has severely reduced the ability of this area to support good forest growth. Lands to the north of this burned section, extending from the Roseway River to the Medway River, south of Lake Rossignol, are able to support good forest growth, although their origins are similar, because they have been less severely burned.

(412b - Leipsigate Lake)
Soils in this sub-unit are predominantly shallow, Bridgewater series. North of Minamkeak Lake, and between Leipsigate and Hebb Lakes, Rockland occurs.

(412c - Rocky Lake)
Well drained, but shallow, Farmville soils derived from slaty to gravelly tills occur with Farmville and occasional Bridgewater drumlins.

VEGETATION

The south western part of this unit has been the most extensively burned. The natural vegetation appears to have been White Pine and Red Oak, but now many of the hills only support low shrubs and scattered Black Spruce. Barren and semi-barren areas with depleted soils are now colonized by Huckleberry which appears after cutting and after fires. In deeper soil areas White Pine with intolerand hardwoods occurs with Red Oak on the ridges.

Describing the south-western section of this unit in 1912 C.D. Howe wrote as follows: "... Deep sands to coarse materials covered only with a thin layer of sand, may be found spread out in billowy masses. Such sands are very common ... giving rise to extensive areas of white pine forests; while the coarse materials are frequent along the southern border of the granite ... Being heavy and coarse they never got far from their original source. ... They are barren or semi-barren because of too thorough drainage and natural poverty of plant food materials... One frequently finds drained lake beds in the possession of coarse grasses and sedges. ... The lower and middle courses of the rivers ... from the Clyde to the Sable are characterized by low undulating deposits of sand interspersed by rocky or gravelly ridges, bogs and swamps. The two latter are most extensive in the valleys of the Clyde and Sable where they occupy from one-third to one-half of the area. They contain spruce and fir pulpwood in about equal proportions, usually, however, the spruce predominates. One finds in these regions, blocks of several thousand acres, not over five percent of which are forested, the rest being barren, open bogs and brushland. Thickets of wire birch, red maple and red oak cover the gravelly and rocky ridges. Along the bases of the ridges the yound hardwoods are mixed with spruce an fir."

In the less severely burned areas south of Lake Rossignol the undulating terrain supports hemlock and Red Spruce with some tolerant hardwoods on well drained sites. Very large Yellow Birch are found in these forests (sometimes referred to as "Black Birch"). Large expanses of organic soils support mature trees. Deeper organic soils are characterized by Red Maple and Ash while shallower organic soils support hemlock. The luxurious understorey in these "Hemlock Swamps" contains larger than usual Interrupted Ferns.

In the lower valleys of the Jordan and Sable Rivers sandy soils are found which are extensively burned and support White Pine stands with Red Oak. Further inland the Upper Ohio area which has not been heavily burned is characterized by Red Spruce, Hemlock and White Pine on the drier ridges with more Yellow Birch than elsewher.

Coastal plain plants are relatively common in this unit.

FAUNA

Because of the large areas of barren and bog this unit does not provide much productive wildlife habitat. Snowshoe Hare and Bobcat, are relatively abundant, and some Black Bear habitat can be found. The most common small mammals are the Common Shrew, Short-tailed Shrew, Red-Backed Vole and the White-footed Mouse. Rivers and lakes are acid and often dystrophic with low natural productivity. Painted Turtles are found here. Snakes are unusually common in the "Hemlock Swamps".

SITES OF SPECIAL INTEREST

Tobeatic Game Sanctuary (Provincial) - see also Unit 440a.
Burnaby Lake (IBP Proposed Ecological Site 42)
- mature Red Spruce stand.
Shelburne River (IBP Proposed Ecological Site 43)
- old growth Hemlock stand.
Sixth Lake (IBP Proposed Ecological Site 44)
- Red Spruce, Hemlock forest.
Broad River (IBP Proposed Ecological Site 45)
- Red Spruce forest.
Silvery Lake (IBP Proposed Ecological Site 47)
- Old growth Hemlock forest.
Provincial Parks and Park Reserves
- Ten Mile Lake
- Welcum

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T35 Hardpans, T44 Vegetation Change, T46 Vegetation and the Environment, T58 Amphibians and Reptiles.

ASSOCIATED HABITATS

H11 Freshwater Lake, H14 Blanket and Raised Bogs, H17 Barren.

UNIT 413: QUARTZITE BARRENS

The Quartzite Barrens are divided into two sub-units:
a) Halifax
b) Guysborough

GEOLOGY AND GEOMORPHOLOGY The mantle of quartzite till ranges in thickness from three to thirty feet (1-10 m) in this unit but averages less than ten feet (3 m). There are several large areas of exposed rock where the till has been scraped off by glacial ice. Specific localities are:

- north and west of Mount Uniacke,
- around the Halifax International Airport,
- around Anderson Lake in Dartmouth,
- several areas from the Liscomb Game Sanctuary to Country Harbour River.

The bedrock dominated topography of these extensive barrens is best described as, "Ridge-Swamp-Swale" in seemingly endless repetition. Where greater thicknesses of glacial till have accummulated drumlins and drumlinoid till features are found.

Throughout the area there are occasional scattered welt shaped drumlins, units 435a and b, of reddish Lawrencetown till (Wolfville soils). This glacial material is derived predominantly from the reddish sandstones and siltstones of the Carboniferous and Triassic areas to the north but also includes material from the Cobequid Hills and Pictou-Antigonish Highlands.

Additional small patches of "unmoulded" red till are found in central Guysborough in association with small amounts of glacial outwash deposits. At Indian Harbour River the valley is filled with thick layers of outwash sand and gravel.

In the Halifax-Guysborough area the many long sub-parallel faults create linear valleys which are followed by rivers and sometimes filled by lakes, for example, Porter's Lake, Lake Charlotte, Sheet Harbour River, Indian Harbour/St. Mary's River.

The Quartzite Barrens have been the most productive area in Nova Scotia for gold mining during the past century, with mines at Goldboro, Goldenville, and Waverley.

SOILS

(413a - Halifax)
Much of this area is covered by Halifax soils - well-drained, stoney sandy loams, developed on till derived principally from quartzite. The poorly drained associate, Danesville, occurs in areas of low relief, together with Aspotogan soils and peat. Some Bridgewater soil, derived from slates, is also found. Scattered, Wolfville drumlins occur, with larger areas of continuous Wolfville soil in the Beaverbank and Dollar Lake areas, see unit 436.

(413b - Guysborough)
Halifax, Danesville and Aspotogan soils again predominate. Scattered Wolfville drumlins occur, concentrated in the central part of the sub-unit, see unit 435. Hebert, Cumberland and Chaswood soils have developed on alluvial and outwash material along the St. Mary's River.

VEGETATION

In this unit the higher and broader ridges are capped by Beech, Yellow Birch, Red Maple and Sugar Maple. On the hardwood hills around Liscomb big Sugar Maples and Yellow Birch (sometimes known as Black Birch) occur. Mixed stands of Red Spruce fringe these hardwood hills with some Balsam Fir, Yellow Birch, Hemlock and White Spruce. In the depressions swamps dominated by Black Spruce and Larch alternate with patches of sand with some White Pine. Slow moving streams are bordered by broad swampy areas with Balsam Fir, Red Maple and Black Spruce. Extensive areas of shrub-dominated barrens occur, with Wire Birch, Red Maple and Aspen. Scattered Black Spruce and White Pine are also found on the barrens, depending on soil drainage conditions.

This impoverished forest area was characterized as follows in 1912 by C.D. Howe. Since he wrote there has been a reduction in the number of fires and consequent improvement in the forest conditions. "In the western portion, the country has the appearance of a plateau, in which the low narrow ridges have nearly vertical strata, bare of soil and bare of trees except in the crevices of the rock. The depressions between the ridges are filled with patches of sand, on which are pine stands alternating with swamps in which balsam fir and black spruce predominate. The broader and higher ridges are capped with hardwoods and mixed stands are found on the lower slopes. Most of these are now in a severely culled or second growth condition. The slow moving streams are bordered by broad swampy areas in which fir and red maple form two-thirds of the stand, the other third being made up of black spruce, yellow birch and black ash in about equal proportions. ... (To the east) the ridges are farther apart and have more extensive sand deposits and bogs between them. ... The fire barren on the quartzite east and northeast of Halifax harbour is covered to the extent of 80 percent with wire birch, the rest being red maple with scattering yellow birch and beech. Fir prevails along the margins of the numerous lakes and ponds and it frequently covers the tops of low ridges. Overtopping these are scattered mature white pine and an occasional red pine. ... For the most part the surface is strewn with boulders and the soil is sandy, although the greater part of the volume is occupied by pebbles and boulders of various sizes. ... It is evident that such soil does not encourage heavy forest growth, even when not pauperized by frequent fires."

FAUNA

Extensive forest cutting has provided good browsing habitat for deer and Snowshoe Hare. The abundance of hare also supports a good population of Bobcat. Small mammal diversity is moderately high in well-drained mixed and hardwood forest habitats especially along rivers and streams; elsewhere it is quite low. St. Mary's River is an important salmon river.

SITES OF SPECIAL INTEREST

Indian River
- fault valley filled with glacial outwash deposits.

Route 101 to Mt. Uniacke from Halifax
- bedrock ridges overlain with a veneer of quartzite till. An occasional cross cut drumlin.

Liscomb Game Sanctuary
- Abraham Lake (IBP Proposed Ecological Site 31) - mature Red Spruce forest.

Melrose (IBP Proposed Ecological Site 27)
- Old growth Hemlock forest.

Provincial Parks and Park Reserves

- Hemlock Ravine
- Mount Uniacke
- Bell
- Cockscomb Lake
- Rocky Lake
- Porto Bello
- Lake Echo
- Lawrencetown
- Lake Charlotte
- Salsman
- Sheet Harbour
- Stillwater
- Sherbrooke

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T55 Small Mammals, T57 Carnivores.

ASSOCIATED HABITATS

H12 and H13 Streams, H16 Swamp, H17 Barren, H27 Sugar-Maple, Yellow Birch, Beech Forest.

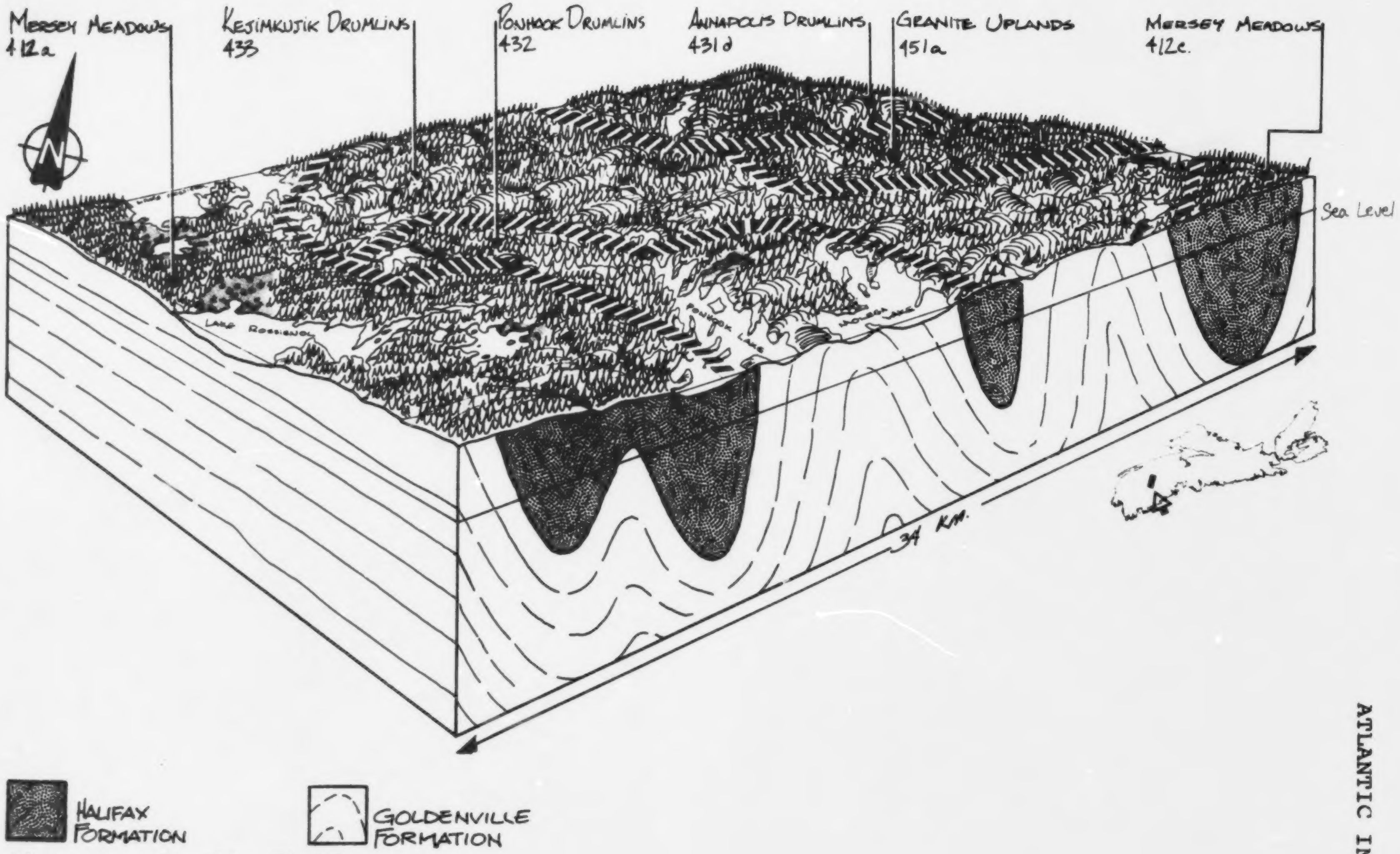

Mersey Meadows
412a
Kejimkujik Drumlins
433
Ponhook Drumlins
432
Annapolis Drumlins
431d
Granite Uplands
451a
Mersey Meadows
412c
Sea Level
Lake Rossignol
Ponhook Lake
N
34 KM.
Halifax Formation
Goldenville Formation

Plate 5. Drumlin Field
Major features on the peneplain surface of Meguma Group rocks which dominate the Atlantic Interior (400) are lakes and drumlins. Three types of drumlins are shown; those derived from slate (433), which hold moisture through the summer and loose, droughty, drumlins derived from granite (431) or quartzite (432). Lakes and associated bogs of the otherwise featureless Mersey Meadows (412) are shown in the left foreground.

420 Slopes and Ridges

GEOLOGY AND GEOMORPHOLOGY	The geology in this district is dominated by Halifax slate which occurs in folds within the Goldenville greywacke. In most units the slate is overlain by Silurian White Rock volcanics and also sometimes by Early Devonian sandstones.

The units within this district are distributed around the northern and western margins of the Atlantic Interior. Their topography reflects the somewhat lesser resistance of slate in contrast to that of the surrounding strata. There are seven localities within the District; in two the slate forms ridges, in two it forms valleys on the Upland slope, and in the remaining three it has been buried by glacial deposits and forms a flat lowland. These units are as follows:

421	Sissiboo Lowland
422	South Mountain Slope
423	Slate Ridges

UNIT 421: SISSIBOO LOWLANDS

This unit has three subdivisions:
- a) Sissiboo River
- b) Meteghan Lowlands
- c) Lake George

GEOLOGY AND GEOMORPHOLOGY These areas are underlain by synclines containing Halifax slate with, in the Sissiboo and Lake George areas, thicknesses of Silurian White Rock volcanics.

The three sub-Units lie within the Digby-Yarmouth area and share the same complex glacial history (see also Unit 411). Four separate glacial phases have been recognized from the last ice advance. In the first phase the ice came from the east and produced a grey till derived from local material. The second pulse was the major one from New Brunswick, which engulfed the entire province and in this area deposited a red till (Red Head Till). The third pulse of glacial ice flowed parallel to the coastline and was presumably from an ice sheet in Nova Scotia; it deposited the Saulnierville Till. Finally, a weak flow from an ice cap on the Southern Uplands deposited the loose material of the Beaver River Till. The Beaver River Till is at the surface over most of the area as the quartzite till and slate till from which the soils have formed. Both it and the Saulnierville Till contain fragments of Meguma Group rocks and the White Rock volcanics. The relationship between the four different till layers are best seen along coastal sections although occasionally inland a lower till is only partly covered and is revealed in the centre of younger till deposits, for example, from Cape St. Mary north to Lac de Gruau.

The three areas differ somewhat in the composition of the Beaver River Till exposed on the surface. In both Sissiboo River and Meteghan Lowlands slate tills and drumlins predominate whereas at Lake George till and drumlins are composed predominantly of quartzite.

There are a few isolated deposits of water-deposited debris within this Unit; the best examples can be found along the shore of the Tusket River (Unit 831, Tusket Islands). There are one or two isolated eskers, one is found on the west side of Gaspereau Lake in the Meteghan Lowlands.

Overall the Sissiboo Lowlands have a low relief and a stoney drumlin terrain. Lakes are numerous and are elongated north-south, often forming chains.

SOILS

(421a - Sissiboo Lowland)
Well drained Bridgewater and imperfectly drained Riverport soils, both sandy loams derived from slate, occur in this sub-unit.

(421b - Meteghan Lowland)
Near the coast Riverport and Bridgewater soils occur on gentle to undulating terrain. Further inland well drained Mersey and imperfectly drained Liverpool soils have developed from schists and quartzite, accompanied by poorly drained, mottled Pitman soils and areas of peat.

(421c - Lake George)
Moderately well drained Yarmouth soils derived from schist and quartzite occur, with mottled Deerfield soils in areas with less relief. Liverpool and Pitman soils occur on very flat areas. To the north of this sub-unit some well-drained Medway soils have formed on sands and gravels.

VEGETATION

This entire unit exhibits excellent forest growth on schisty and slatey soils. Sub-unit 421a has considerably more hardwoods than the other sub-units. The terrain is rolling, and on better drained sites Beech and Red Oak with Sugar Maple, Yellow Birch and Aspen grow, interspersed with intolerant hardwoods. On the moderately drained sites a Red Spruce and Black Spruce mixture occurs. Ash is mixed with the spruces on Deerfield soils. The intolerant hardwoods (Red Maple and White Birch) are also mixed with Ash on the Pitman soils. Sub-unit 421b is predominantly mixed wood with Red Spruce, Black Spruce and intolerant hardwoods. Sub-unit 421c has been very heavily disturbed. Many areas are still actively farmed, while pure stands of White Spruce have recolonized old fields and pastures. Beech, Yellow Birch and intolerant hardwoods are abundant.

Shorelines of lakes and streams may include coastal plain plants considered as rare in Nova Scotia. The reader is referred to Roland and Smith (1969) for more information.

FAUNA	An inland breeding colony of Black-backed Gulls and Double-crested Cormorants occurs at Lake George. Freshwater habitats have a relatively rich aquatic fauna with some coastal plain species of molluscs and arthropods.
SITES OF SPECIAL INTEREST	Placid Lake (IBP Proposed Ecological Site 56) - dystrophic lake, flood plains and old growth Hemlock stand. Provincial Parks and Park Reserves - Ellenwood Lake - Corberrie

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T24 Modifying Forces.

ASSOCIATED HABITATS

H18 Oldfields.

UNIT 422: SOUTH MOUNTAIN SLOPE

a) Bear River
b) Gaspereau Valley

GEOLOGY AND GEOMORPHOLOGY The two sub-Units of the South Mountain Slope, Bear River and the Gaspereau Valley, are underlain by Halifax slate (Cambrian-Ordovician) interfolded with White Rock Group volcanics (mostly ash) and sandstone (Silurian), and Torbrook sandstones and siltstone (Early Devonian). The younger White Rock and Torbrook deposits are preserved in synclines.

The volcanic ash deposits are relatively thin in this area compared to the 10,000 feet (3,000 m) of ash and lava in the Yarmouth area. They contain no volcanic bombs nor offer evidence of a volcanic centre nearby and add weight to the view that the Silurian volcano was well over 60 miles (100 km) to the south near Yarmouth.

The slates, sandstones, siltstones and ash deposits are truncated to the south by the contact with the South Mountain granite. To the north they are overlain by soft Triassic deposits in the Annapolis Valley. They are therefore intermediate in hardness and form a dissected shoulder to the granite next to the low-lying valley floor. Deep valleys have been cut in these relatively unresistant rocks (relative to the granite outcrops to the south). Bear River has cut a deep valley across the fold axis of the slates to reach the Annapolis Basin, which is cut into even less resistant sandstones. The Gaspereau, on the other hand, follows the fold axis and flows parallel to Annapolis Valley sandstones before emptying into the Minas Basin.

(422 a - Bear River)
Overlying the Bedrock in the Bear River area is a thick glacial till derived from the Halifax slate. This, in turn, is overlain by a thin clay till veneer. Along the coast are thick deposits of outwash gravel which form a series of terraces from The Joggins in the west to Cornwallis in the east. These date from the immediate post-glacial period when sea level rose rapidly as the ice caps melted. The sands and gravels washed down from South Mountain formed terraces, beach deposits and deltas at sea level. When the land rebounded in response to the removal of the ice, the sea level became relatively lower and

deposits were left well above high tide. At the same time, in response to the lowering of the sea level, Bear River and Acadia Brook both deepened their valleys.

(#422b - Gaspereau Valley)
The western part of this sub-Unit is covered with Rawdon till, a ground moraine derived from a mixture of slate, sandstone and carbonate rocks. Along Halfway River, north and south of Greenfield are pockets of glacially derived gravel which may be kames and kame terraces. Eskers are also indicated.

An interesting geographic feature in this area is the classic example of river capture shown by the Gaspereau River. The Gaspereau with a lower base level cut back towards the Black River which originally flowed directly northwards through Deep Hollow to join the Cornwallis River. The Gaspereau River eventually captured the headwaters of the Black River leaving an undersized stream to flow through the original valley and a wind gap just north of White Rock.

SOILS

Soils derived from shaley loam glacial tills characterize this unit. Bridgewater soils, derived from slatey till, and its associates Riverport and Middlewood soils dominate the Bear River area (422a). Due to the proximity of various other rock types and different directions of glacial movement a number of other soils are present including Wolfville (red-brown sandy till) and Digby (outwash deposits). In the Gaspereau Valley, area 422b, the reddish-brown shaley loams have produced Morristown soils. Very steep slopes along the river valleys throughout the Unit have unstable soils with seepage spots.

VEGETATION

This unit has been extensively cut over, and supports a considerable amount of agricultural activity. The soils are usually deep and support productive mixedwood forest with spruce, pine, hemlock, aspen and intolerant hardwoods.

FAUNA

The Gaspereau valley provides Bald Eagle wintering habitat. The Gaspereau river supports abundant fish spawning runs of Gaspereau and some Striped Bass.

In the lowland cultivated areas small mammals are predominantly those species associated with non-forested habitats, for example the Meadow Vole and Meadow Jumping Mouse. The small mammal diversity is relatively high in well-drained mixed and hardwood forest habitats especially along rivers and streams; elsewhere it is quite low.

SITES OF SPECIAL INTEREST

Gravel terraces
- Bear River above highway bridge at Roop Point, terrace 90 feet (27 m) above sea level.
- Bear River, east of river mouth, gravels 100 feet (33 m) above sea level.
- Deep Brook, terrace 140 feet (42 m) above sea level.
- Smiths Cove, fine stratified sands 100 feet (33 m) above sea level.
- The Joggins, fine sands extending westwards for 2.5 miles (4 km).

Gaspereau Valley
- river capture, wind gap at Deep Hollow.

ASSOCIATED TOPICS

T50 Birds of Prey

ASSOCIATED HABITATS

H18 Oldfield .

UNIT 423: SLATE RIDGES

a) Rawdon Hills
b) Wittenburg Ridge

GEOLOGY AND GEOMORPHOLOGY

The Rawdon Hills and Wittenburg Ridge are two ridges of slate located at the margins of the Windsor Lowlands (511a). They may both be ancient landscape features dating back to the pre-Carboniferous period. The Wittenburg Ridge may have been an island or peninsula in the Early Carboniferous sea that covered this part of the province, since the Horton deposits wedge out on its flanks. The same does not appear to be true for the Rawdon Hills which were probably engulfed early in this depositional period.

The two ridges are abutted by Early Carboniferous deposits. Both Horton and Windsor deposits outcrop against the Rawdon Hills, while the Wittenburg Ridge is almost surrounded by Windsor Group deposits. Where Halifax slate and Windsor deposits are juxtaposed, the latter are preferentially eroded leaving the slate as higher land. This situation is in contrast to the more common relationship of slate and greywacke in which the slate, being softer, forms valleys.

Both the Rawdon Hills and Wittenburg Ridge are covered by sheets of the reddish Lawrencetown till, which is derived from the Carboniferous lowlands, interspersed with locally derived grey till.

Both ridges are drainage divides but the Rawdon Hills are also cross-cut by a number of streams which are tributaries of the Avon River. The Herbert River, Meander River and Glen Brook all have valleys which lie directly across the ridge and which must have been superimposed by downcutting from a higher level. These three river valleys also contain extensive deposits of outwash gravel on the northern side of the ridge where the slope meets the Windsor Lowlands.

SOILS

(423a - Rawdon Hills)
Soils in this sub-unit have developed from slates and shales. Soils of the Rawdon catena are most common; they are shaly, sandy loams derived from slates and shales, ranging from rapidly to

moderately slowly drained. Elmsdale soils also occur, derived from shales and sandstones, with slate and quartzite cobbles.

(423b - Wittenburg Ridge)
Queens clay loams occur on the slopes, with some imperfectly drained Hantsport soil north of Upper Musquodoboit. On top of the ridge well drained Kirkhill shaly loams occur, with small areas of poorly drained Middlewood and Riverport soils, developed from shaly loams.

VEGETATION

While the Rawdon Hills and the Wittenburg Ridge are considerably lower than the other areas included in Loucks' Sugar Maple-Yellow Birch- Fir Zone (Maritime Uplands Ecoregion), they are still high enough to produce local climates that encourage tolerant hardwoods (H.27). These occur as stands of Sugar Maple, Yellow Birch and Beech, but extensive cutting has produced a predominantly mixed wood forest with Red Spruce, Hemlock, pine, Balsam Fir, maple, birch (H.24) and Ash. A vigorous understorey is present throughout the Slate Ridges Unit composed of Balsam Fir and Red Spruce under hardwood stands. Pine is somewhat less common on the Rawdon Hills.

ASSOSIATED TOPICS

T6 The Carboniferous Basin: An Inland Sea.

ASSOCIATED HABITATS

H27 Sugar Maple, Yellow Birch, Beech Forest.

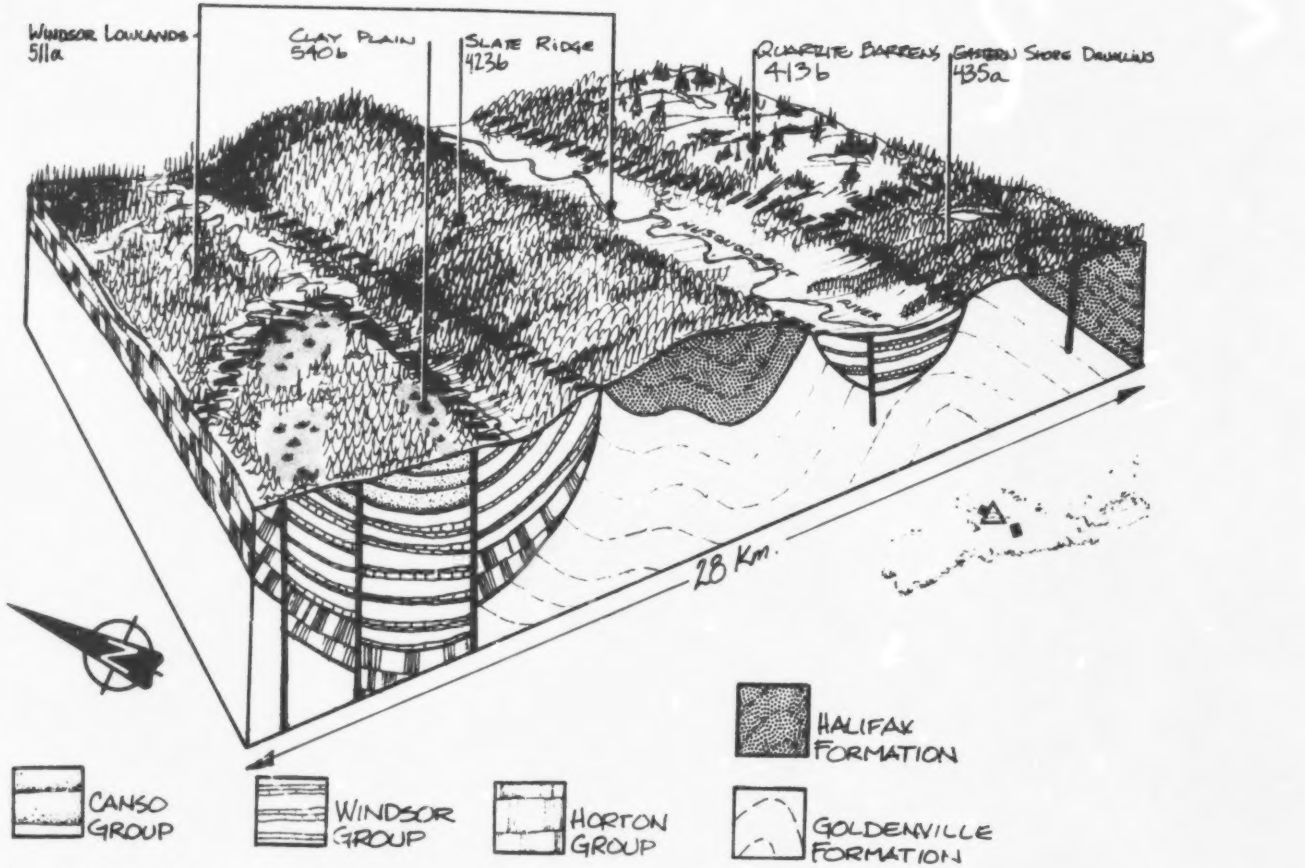

Windsor Lowlands
511a
Clay Plain
540b
Slate Ridge
423b
Quartzite Barrens
413b
Eastern Shore Drumlins
435a
Musquodoboit River
28 Km.
N
Canso Group
Windsor Group
Horton Group
Halifax Formation
Goldenville Formation

Plate 6. Wittenberg Ridge
This outlying ridge of slates (423) is part of the ancient landscape that is still being exhumed from its cover of more recent sedimentary rocks. To the north of the ridge is the South Branch of the Stewiacke River while to the south is the Musquodoboit River Valley, both of which form parts of the Windsor Lowlands Till Plain (511). In the background are parts of the Atlantic Interior; Quartzite Plains (413) and one of the Eastern Shore Drumlin fields (435). In the foreground the flat lying clays derived from the Canso Group rocks form the poorly drained Clay Plain (540).

430 Drumlins

GEOLOGY AND GEOMORPHOLOGY

Drumlins in Nova Scotia are mostly confined to the Atlantic side of the province, where the ice moved across level areas or down a slope, with a free exit to the continental shelf. Most of the drumlins are associated with the slate areas. Slate strata are sheared off more readily and to a greater depth than other types of strata, so that a large amount of material is available for moulding by the action of the ice. Drumlins in Nova Scotia are rare along a band one to three miles (2-5 km) wide on the northwestern side of a slate area, but to the southeast they may extend for several miles into a greywacke area. Occasional drumlins may be found in a granite area, but generally they quickly disappear once the granitic border is crossed. This restriction to the slate areas is not so well marked in the Halifax-Guysborough area, for drumlins sometimes appear in a predominantly greywacke area where the bands of slate are rather narrow and widely separated. Here, perhaps, more material had been accumulated from the areas farther north. Carboniferous materials with a distinctively red colour form the eastern sections of the large drumlin field in Lunenburg County (434) as well as drumlins on the Eastern Shore and north of Halifax. Isolated "red" drumlins may occur in any part of the Atlantic Interior. Slate drumlins are "grey", providing an easy field identification of the origins. Almost all drumlins, of any origin, local or distant, seem to exhibit a thin cover of granite pebbles and boulders.

Drumlins were formed with their long axes parallel to the direction in which the ice was moving. Those in southwestern Nova Scotia indicate a nearly southerly ice movement becoming southeasterly in eastern Lunenburg and western Halifax counties. Drumlins around Halifax show about the same size and orientation as those in central Lunenburg County. However, from Sheet Harbour east to beyond the Guysborough County border, the drumlins again have a north-south orientation, as if they were formed by ice which moved directly down from the Gulf of St. Lawrence. The few around Canso are oriented more to the southeast. In general it appears that the ice moved directly across central and western mainland Nova Scotia from New Brunswick, whereas in eastern Nova Scotia, the ice moved southward from Pictou and Antigonish counties and spread out to the east into Chedabucto Bay.

There is great variation in the composition of the drumlins. Most are composed of fine-textured tills derived from the underlying or adjacent rocks. In several areas material from Carboniferous rocks to the north composes the drumlins or drumlin field.

431 Annapolis Drumlins - granitic materials
432 Ponhook Drumlins - quartzite materials
433 Kejimkujik Drumlins - slate materials
434 Lunenburg Drumlins - Carboniferous
435 Eastern Shore Drumlins materials,
436 Headwater Lakes predominantly
"red" drumlins with
some slate.

UNIT 431: ANNAPOLIS DRUMLINS

a) Fisher Lake
b) Spectacle Lake
c) Alma Lake
d) Round Lake

GEOLOGY AND GEOMORPHOLOGY The Annapolis Drumlins are found in four, small, isolated localities on the South Mountain Granite. Drumlins do not normally form from granitic material. Where they have formed these drumlins frequently have a rock core. Occasional granitic drumlins are found in non-granite areas such as on Graves Island but this is unusual. These drumlins contain large granite boulders, are often well or even excessively well drained with similar soil characteristics to the Gibraltar soils.

VEGETATION The drumlins provide very productive forest sites. On the better drained tops and slopes a mixed forest is most common, with Hemlock, Red Spruce, White Pine, Sugar Maple, Yellow Birch and some Red Maple. On the wetter sites between the drumlins spruce, fir and pine with intolerant hardwoods predominate. Ash is often found on the steep side slopes where seepage occurs.

UNIT 432: PONHOOK DRUMLINS

GEOLOGY AND GEOMORPHOLOGY

The Ponhook Drumlins lie on a narrow belt of greywacke within the slate-dominated area northeast of Lake Rossignol. The till sheet and drumlins are composed of quartzite till and their distribution almost exactly coincides with the boundaries of the greywacke from which they were derived. This illustrates how closely the bedrock geology and the composition of the till are related in this part of the Atlantic Interior. The till cover ranges from 3 to 35 feet (1 - 10 m), and averages 10 feet (3 m), in thickness. The drumlins are generally low, 6 to 65 feet (2 - 20 m) high and are strongly aligned northwest-southeast.

These drumlins are very stoney and the matrix containing the rocks is very porous. Drainage is therefore excessively rapid in these Halifax, sandy loam soils.

The terrain in this area is very flat, with most of the relief being provided by the drumlins. Overall the landscape is hummocky with many lakes.

VEGETATION

These dry drumlins support a mixture of White Pine, Red Oak and Aspen with some intolerant hardwoods. Burned areas often regenerate in beech and aspen.

UNIT 433: KEJIMKUJIK DRUMLINS

GEOLOGY AND GEOMORPHOLOGY The Kejimkujik Drumlins or "grey" drumlins cover an extensive area from Lake Kejimkujik to the drainage basin of the southwestern branch of the LaHave River. The underlying bedrock is entirely composed of Halifax Slate, and it is from this that the till sheet is derived. The till ranges in thickness from 3 to 35 feet (1 - 10 m) and has a loose matrix with fragments of bedrock. The drumlins are composed of slatey (Hartlen) till which is compact and clayey.

The landscape of the Kejimkujik Drumlins is hummocky with the relief provided entirely by the low drumlins, 50-100 feet (15-30 m) high. The drainage pattern is deranged and there are many irregularly shaped lakes. Most runoff in this area is eventually directed to the Medway or LaHave Rivers.

The coastal equivalent of Unit 433 is described in Unit 832, LaHave Drumlins.

SOILS Soils in this Unit have been mostly derived from slate. Bridgewater soil, well drained sandy loam, mantles both the drumlins and the ground in between. Many of the drumlins have been cleared. In the southwest area of the unit there is a spillover of Bridgewater drumlins into an area of Halifax soils derived from quartzite. On flat and depressed terrain, pockets of poorly drained Riverport and Middlewood soils occur. There are also a few small areas of coarse-textured LaHave and Torbrook soil developed on water deposited materials.

VEGETATION This Unit, together with Unit 434, Lunenburg Drumlins, falls within Loucks' Sugar Maple-Hemlock-Pine Zone, in which tolerant hardwoods are found on a wide range of sites. The bowl-shaped depression occupied by this unit has a distinct local climate: relatively low rainfall and relatively high summer temperatures. The climax forest for much of the unit is Sugar Maple, Yellow Birch and Beech (H.27), but extensive disturbance by fire and cutting has resulted in large areas of mixed forest - Red Spruce, Hemlock, pine and Balsam Fir with the intolerant hardwoods, maple and birch (H.24 and H.25). Vigorous regeneration of disturbed sites by Balsam Fir has formed the basis for the Christmas Tree growing industry in this and the adjacent unit (434). In this unit the coarser, drier soils on some drumlins support more White Pine, and more hardwood stands - particularly Beech, Trembling Aspen and Red Oak. Many of the drumlins tops are cleared for agriculture, or have been colonized by a post-fire maple, oak, birch association (H.22).

Many coastal plain flora species can be found in this unit. The disjunct species Golden Crest has been found in wet areas near Fancy Lake, Lunenburg County.

FAUNA

The warm summer temperatures permit the existence of a distinct relict fauna, including Blanding's Turtle, the Northern Ribbon Snake, and the wood tick. It also allows for both greater species diversity and greater numbers of reptiles and amphibians. The hardwood forests provide good Ruffed Grouse habitat. Extensive agricultural settlement provides open land habitat. Distinctive birds include the Scarlet Tanager, Great Crested Flycatcher and Wood Thrush.

SITES OF SPECIAL INTEREST

Part of Kejimkujik National Park
Big Dam Lake (IBP Proposed Ecological Site 63)
- old-growth Hemlock forest.

Provincial Parks and Park Reserves
- Fancy Lake
- Cookville
- Cameron's Brook
- Nineveh

ASSOCIATED TOPICS

T58 Amphibians and Reptiles

ASSOCIATED HABITATS

H11 Freshwater Lake, H18 Oldfield, H22 Maple, Oak, Birch Forest, H28 Pine Forest.

UNIT 434: LUNENBURG DRUMLINS

GEOLOGY AND GEOMORPHOLOGY	These "red" drumlins are composed of materials carried into the area from a distance of at least 20 miles (30 km) to the north. In some instances the reddish Carboniferous rocks have been carried at least 40 miles (60 km) and probably further. These distinctive red tills form prominent drumlins up to 80 feet (25 m) in height. Occasional slatey till drumlins derived from local material are found amongst the red drumlins. Two reddish tills have been distinguished; the clayey Hartlen Till and the sandier Lawrencetown Till. Most drumlins have a core of Hartlen Till and a mantle of Lawrencetown Till. This drumlin field reaches the coast in unit 832.
SOILS	Drumlins in this Unit are mantled in reddish-brown Wolfville soils, well drained loams over sandy clay loams containing Carboniferous material. Soils between the drumlins are mostly Bridgewater sandy loams derived from slate, with poorly drained associate Riverport soil on flat land. Swamp and peat areas are more common towards the coast where there is less relief.
VEGETATION	This unit, together with Unit 433 Kejimkujik Drumlins, falls within Loucks' Sugar Maple-Hemlock-Pine Zone, in which tolerant hardwoods are found on a wide range of sites. This is because the Unit is situated in a bowl-shaped depression, having a distinct local climate: relatively low rainfall and relatively high summer temperatures. The climax forest for much of the unit is Beech, Sugar Maple and Red Oak, but extensive disturbance by fire and cutting has resulted in large areas of mixed forest - Red Spruce, White Pine, Hemlock and Balsam Fir. The heavier Wolfville soils on the drumlins result in less White Pine, more Red Spruce, and few pure hardwood stands. Many of the drumlin tops have been cleared for agriculture. Regeneration is predominantly spruce and Balsam Fir. The vigour of the Balsam Fir growth has resulted in the establishment of the Christmas Tree growing industry in this and the adjacent unit (433). If left Balsam Fir is replaced by other tree species after about thirty years.

FAUNA	The warm summer temperatures permit the existence of a distinct relict fauna, including Blanding's Turtle, Northern Ribbon Snake and the Southern Flying Squirrel. The wood tick, an introduced species, is common. The reptiles and amphibians are found in great numbers and considerable species diversity. Small mammal diversity within the Atlantic Interior Region is probably highest in this Unit.
SITES OF SPECIAL INTEREST	Provincial Parks and Park Reserves - Pinehurst - Wentzell's Lake - Maitland

ASSOCIATED TOPICS AND HABITATS:

See Unit 433

UNIT 435: EASTERN SHORE DRUMLINS

a) Tangier River
b) Moser River

GEOLOGY AND GEOMORPHOLOGY	Unit 435 is underlain by interfolded greywacke and slate, which form a series of wide bands oriented east-west. These are overlain by a thin quartzite till (averaging three metres in thickness) and, in the Moser River area, by a mixture of quartzite and Lawrencetown tills called Red Till. Above these are drumlins of red, sandy Lawrencetown Till. The latter is derived from the Carboniferous Lowlands to the north and contains fragments of rock from the Cobequid Hills and the Pictou - Antigonish Highlands. In the Moser River watershed there are several deposits of outwash sands and gravels. The largest ones fringe Necum Teuch Bay. The relief in both the Tangier River and Moser River areas is low with most of the visual variety being provided by the drumlins. The average elevations are different in the two areas, however. At Moser's River the hills rarely exceed 250 feet (80 m) while in the Tangier River area the hills average 325 to 425 feet (100 to 130 m). The drainage in both areas is deranged with many irregular shaped lakes.
SOILS	(435a - Tangier River) The drumlins are mantled in medium textured Wolfville loam over sandy clay loam till containing Carboniferous material. Between the drumlins the soil is mostly imperfectly drained Danesville sandy loam, derived from quartzite with some better drained Bridgewater soil (derived from slate). (435b - Moser River) The drumlins are also covered with Wolfville soil. Between them the soil is mostly Danesville to the east where the topography is flatter, and better drained Halifax to the west - both derived from quartzite. In depressional areas patches of Aspotogan soil and peat occur.
VEGETATION	Intolerant hardwoods (Red Maple and White Birch) are found on the better drained drumlin tops, with Black Spruce, White Spruce, Balsam Fir and

Larch growing on the wetter sites in between. Red Spruce occurs on the drumlins more frequently in the Tangier River sub-unit.

C.D. Howe noted the prominence of these hardwood ridges in his 1912 survey: "One is impressed by the predominance of yellow birch and paper birch on the hills around the lakes. In some places the former makes up four-fifths of the stand and pure stands of the latter are frequent."

SITES OF SPECIAL INTEREST	Provincial Parks and Park Reserves - Judd's Pool

UNIT 436: HEADWATER LAKES

a) Beaverbank
b) Dollar Lake

GEOLOGY AND GEOMORPHOLOGY

Both localities in this Unit are underlain by parallel bands of greywacke and slate which are oriented east-west. These form a low-ridge/shallow-valley topography which has little topographic variety except where river valleys or lake basins interrupt the rolling surface.

The bedrock is covered by a till sheet dominated by red, sandy Lawrencetown Till. In several areas large areas of rock are exposed. The till sheet changes to a quartzite till composition to the west of Beaverbank Lake where both Lawrencetown and quartzite tills are overlain by a swarm of drumlins composed of Lawrencetown tills.

In general the drainage in both areas is deranged with several small lakes connected by wandering streams. In the Beaverbank area there is also a long chain of lakes (the Waverley Chain) which extend nearly one third of the way across the province to the head of the Shubenacadie River. They may form part of an ancient river system which rose on the Scotian Shelf and flowed northwards during the Cretaceous.

SOILS

(436a - Beaverbank)
Medium textured, red, Wolfville loams are dominant in this unit with some areas of well drained Halifax and imperfectly drained Danesville sandy loam to the north.

(436b - Dollar Lake)
Fairly deep, red, Wolfville soils cover most of this sub-unit.

VEGETATION

Red Spruce and Hemlock are the characteristic species in this unit, with White Pine, Balsam Fir, Red Maple, and Yellow Birch. Intolerant hardwoods occur on shallow soil in burnt areas, whereas tolerant hardwoods grow on well-drained hill tops.

SITES OF SPECIAL INTEREST

Lake Charles to Grand Lake
- the valley of the Waverley Chain of Lakes (part of the Shubenacadie canal system)

Provincial Parks and Park Reserves
- Dollar Lake
- Oakfield
- Laurie

ASSOCIATED TOPICS

T12 Tertiary Drainage Patterns.

440 Granite Barrens

a) Flintstone Creek
b) Bloody Lake

GEOLOGY AND GEOMORPHOLOGY The Granite Barrens are found in two areas in southwestern Nova Scotia, one is at the southwestern extremity of the South Mountain granite, and the other lies directly east of the Tusket River near the Yarmouth County/Shelburne County boundary. As the name indicates the bedrock in each case is granite. Other areas of granite (district 450) also contain extensive barrens. Unit 452 the Shelburne Granite Plain has barrens in its western extremity traversed by Highway 103.

Both areas are overlain with a thin cover of loose, stony granite till with no drumlins. The surface is strewn with boulders and tends to be very difficult to travel since it has poor drainage and there are many streams flowing between shallow irregular lakes and bogs.

The elevations in the two localities are quite different. Flintstone Creek, like most granite areas, stands above its surroundings, in this case at an elevation of over 400 feet (125 m). It is part of the South Mountain granite body and has undergone extensive erosion. However owing to its extreme resistance to erosion the granite is still elevated above the surrounding Meguma strata.

Bloody Lake lies over a small granite exposure which is probably a cupola in a large granite body still lying at depth. It has only recently (geologically) been exposed and thus maintains the same average elevation as the surrounding Meguma terrain, about 100 to 130 feet (30-40 m) above sea level.

SOILS (#440a - Flintstone)
Soils are basically coarse-textured, well drained Gibraltar gravelly, sandy loams derived mostly from granite, with small areas of slowly drained Bayswater and Aspotogan soils on nearly level to depressional topography. All soils are very shallow and stoney, and there are large areas of exposed bedrock. Peat bogs are common and ortstein iron pans are widespread.

(440b - Bloody Lake)
Gibraltar soils occur to the south of the sub-unit, with areas of well drained Halifax sandy loam, derived from quartzite, to the north. Patches of Aspotogan soil and peat are also present.

VEGETATION

Causes of barrens are fivefold: Deep, repeated burns; iron pans; excessive boulders; excessive leaching, causing very low fertility; and the establishment of heath vegetation preventing growth of tree seedlings. Now that fires are better controlled than in the early days of forestry some fire barrens are regenerating in forest species. However limited planting of Red and Jack Pines has resulted only in very slow growth.

Forest vegetation does best in the drainage trenches, alongside the deranged drainage system. Here linear "forests" of Red Maple, some Ash and Wire Birch occur between the slightly higher intervening barren heathlands. The characteristic shrubs on these areas are Huckleberry, Sheep Laurel, viburnum, and alder. Also commmon is a low scrub which may include White Pine, Aspen, Black Spruce, Red Maple, Wire Birch or Oak. On boggy sites Black Spruce, Red Maple and Larch are common. Swamps, swales and bogs occur throughout the unit.

FAUNA

The barrens and semi-barrens are generally unproductive wildlife habitat except for small mammals which have a low to moderately high diversity and Moose which have one of the best populations in western Nova Scotia. Lakes and rivers are yellowish, turbid and acid with considerable amounts of humic matter. Aquatic fauna is poor, but there is some fur-bearer (beaver, otter, muskrat) and duck nesting habitat.

SITES OF SPECIAL INTEREST	Tobeatic Resource Management Area Tobeatic Game Sanctuary Birch Lake (IBP Proposed Ecological Site 61) - old growth White Pine forest Sporting Lake (IBP Proposed Ecological Site 62) - old growth Hemlock and White Pine forest. Quinan Lake (IBP Proposed Ecological Site 50) - an example of virgin mixed forest.

ASSOCIATED HABITATS

H14 Blanket and Raised Bog, H17 Barren.

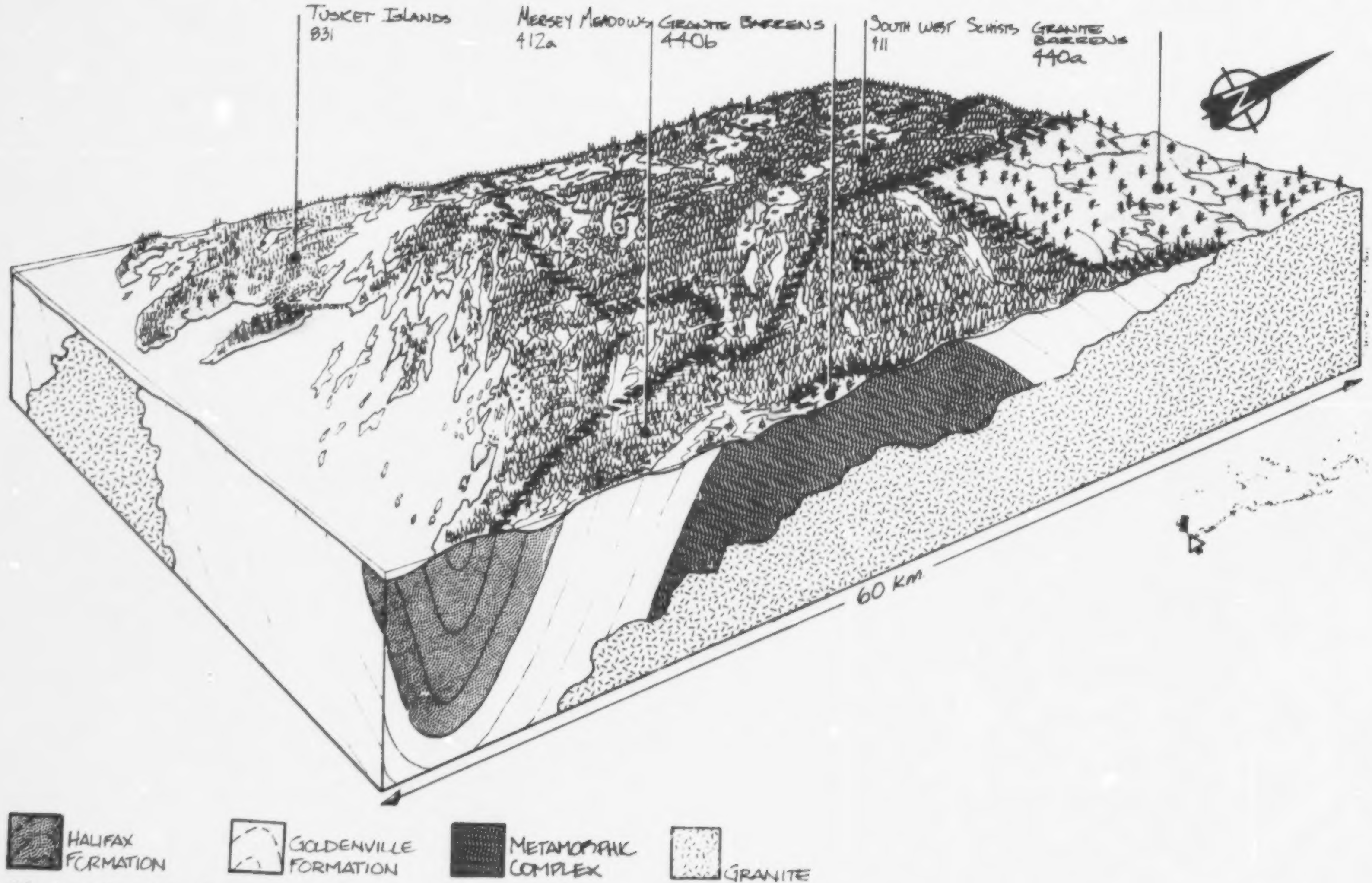

TUSKET ISLANDS
831
MERSEY MEADOWS
412a
GRANITE BARRENS
440b
SOUTH WEST SCHISTS
411
GRANITE BARRENS
440a
60 km
HALIFAX FORMATION
GOLDENVILLE FORMATION
METAMORPHIC COMPLEX
GRANITE

Plate 7. Tusket Islands
The planation surface of the southwestern peninsula dips gently into the Atlantic Ocean. Inland, extensive barrens are mainly confined to granite outcrops (440). Richer soils and more vigorous tree growth are found on the schists (411) than on the impoverished soils derived from the quartzites (412). At the coast the coastal forest is found on a varied landscape of drumlins and salt marshes which provide habitats for interesting and rich flora and fauna (831).

450 Granite

GEOLOGY AND GEOMORPHOLOGY Granite underlies over 50 percent of the Atlantic Interior and outcrops in several areas. The largest granite body is the South Mountain Batholith which stretches in an arc from near the Tusket River across to the Halifax-Dartmouth area. Two other much smaller bodies are the Eastern Shore Granite and the Shelburne Granite. Other smaller outcrops of granite are found throughout the Region.

All of the granite exposed within the Atlantic Interior was intruded during the Acadian Orogeny in the Late Devonian and Early Carboniferous period. It is quite variable in chemical composition, texture and colour but has a common origin in the crustal disturbance of the period.

Granite is very resistant to erosion and tends to form the highest ground in an eroded landscape such as that of the Atlantic Interior. It forms a rounded landscape of shapeless ridges and depressions in which there are occasional knolls.

The drainage across granite is generally severely deranged with most of the low areas across the surface being waterlogged. If the outcrop is narrow it may form a ridge and thus a drainage divide, as does the Eastern Shore Granite.

This district is divided into three units:

451	Granite Uplands
452	Shelburne Granite Plain
453	Granite Ridge

ASSOCIATED TOPICS

T5 Granite in Nova Scotia, T35 Hardpans.

ASSOCIATED HABITATS

H17 Barren , T28 Pine Forest.

UNIT 451: GRANITE UPLANDS

a) South Mountain
b) Ten Mile Stream

GEOLOGY AND GEOMORPHOLOGY

Despite its size the South Mountain Granite is a rather uniform topographic feature. It presents a level horizon when viewed from North Mountain and the surface maintains a steady decrease in elevation down to its southern, eastern and western boundaries where fairly steep slopes mark the boundary with Meguma Strata.

Across the surface of the granite there are many large boulders that were plucked out and then dumped by the ice. Some were carried beyond the granite boundaries and dropped, as erratics, on unrelated rocks further away. Long, prominent eskers occur in the Kejimkujik area and to the west.

The South Mountain Granite has a typically deranged drainage pattern, however two chains of lakes have maintained a more or less straight line across it. One extends south of Milford in Annapolis County and the other south from Panuke Lake. These may represent old river courses which were superimposed upon the granite as it was exposed.

The granite terrain in the Ten Mile Stream area is typical of that seen elsewhere. The surface is elevated above the greywacke and slate bands on three sides by about 150 feet (50 m) but forms a rather steeper escarpment on the northern side where it is undercut by the West St. Mary's River. Here the drop is nearly 350 feet (100 m) in places.

The surface is thinly covered with coarse granite till with some areas of thicker Lawrencetown till. There are some glacial outwash deposits on the northern side.

SOILS

The major soil series throughout this large unit is Gibraltar, a coarse textured, well drained gravelly, sandy loam, derived from granite - usually shallow, heavily leached and very acid. Gibraltar soils are also associated with poorly drained Bayswater and Aspotogan soils, along with many areas of peat. Near the north slope there are also two large areas of Halifax sandy loam derived from quartzite. Bridgetown soils around Gaspereau Lake and south of Hardwood Lake have developed on tills derived from a mixture of basalt, granite, quartzite and Carboniferous material. A small number of Wolfville drumlins also occur near these areas. Scattered areas of exposed rock occur throughout the Unit, and particularly in Halifax County. Soils in unforested areas have a tendency to form hardpans.

VEGETATION

This Unit basically corresponds to the Fisher Lake-Halifax District in Louck's Red Spruce-Hemlock-Pine zone. The characteristic species are Red Spruce, Hemlock, White Pine, Balsam Fir and Red Maple, with scattered Red Oak. Warm summer temperatures result in high evapotranspiration which would normally encourage tolerant hardwoods, here it appears to favour Red Spruce and Hemlock. Fire has played a prominent role, but the regeneration of pine and spruce under Red Maple and Red Oak suggests that the area is returning to a mainly coniferous forest. Beech was formerly abundant, but has been depleted by fire.

White Pine, Red Spruce and Hemlock (H.25) often occur on sites which have not been burnt, while fire stands are commonly Red Oak, Red Maple and White Birch (H.22). Beech, Sugar Maple and Red Oak are found on exposed slopes and hilltops. Black Spruce and Balsam Fir occupy ill-drained lands. Barrens and semi-barrens are common. Some old-growth Red Spruce and Hemlock stands can still be found. Coastal plain flora occur in this Unit.

Observations made in 1912 by C.D. Howe give some historical insight to the development of the present day forests. "The slopes, facing the Annapolis valley, are abrupt with relatively short streams flowing from them, while the southerly facing slopes are gentle, and their streams have worn rather wide valleys separated by low rounded ridges. In the portion draining northward the forests are of the mixed type with red spruce and hemlock predominating over the hardwoods, but there are frequently hills of pure over-mature and decrepit hardwoods, half composed of beech, 40 percent hard maple and the rest, yellow birch. In going southward, especially between the LaHave and Port Medway rivers, hemlock is of more common occurrence than the red spruce, in some places reaching as high as eighty percent of the stand. Frequent barren and semi-barren areas are scattered through the county, doubtless, in most cases, the result of repeated fires. One type, however, approaches the character of a natural barren, that is, a low rocky ridge, usually ten to fifty feet above its surroundings, covered chiefly with scrubby red oak and red maple. The largest areas of these latter barrens are found east and northeast of the Milford lakes and south of the Molly Upsum and McGill lakes. The very numerous lakes and ponds usually have at their upper ends, extensive peat bogs and black spruce and fir swamps. ... The cut of the mills in the western portion of the county (Kings) consists of approximately 50 percent hemlock, 40 percent red spruce and 10 percent white pine, and these species form from 75 percent to 80 percent of the forest. In the eastern portion of the county, the ridges are broader and higher; the hardwoods become more prevalent, and finally dominate. ... Along the basin of the St. Croix lakes the larger percentage of the stands is hemlock. Eastward to the headwaters of Ingram river, red spruce prevails over the hemlock. These areas are near the centre of the granite mass. Both eastward and westward to the limits of the granite in the county, the forest is mixed hardwoods and softwoods, with spruce mostly predominating. ... Southwest of Ingram river and east of Island lake the forest is second growth, paper birch and red spruce being the most common species, with fir and yellow birch next in abundance. Northwest near the Hants County line, hardwood hills compose about one-fifth of the stand, between which red spruce and hemlock prevail, with the spruce in the lead. ... The granite area in the north-western corner of Guysborough county is about one-fourth burned and barren. The soil on the rest is deep, and hardwoods prevail, with frequent patches of pure red spruce and fir."

FAUNA

The second growth mixed wood forests support only sparse wildlife populations. Small mammal diversity is low to moderate. Aquatic habitats are acidic and have low productivity, providing poor waterfowl habitat.

SITES OF SPECIAL INTEREST

Kejimkujik National Park (part)
Hollahan Lake (IBP Proposed Ecological Site 41)
- Jack Pine Forest

Shady Brook (IBP Proposed Ecological site 67)
- Red Spruce, Hemlock forest

Wight Nature Preserve, Hubbards (N.S. Museum)
Provincial Parks and Park Reserves
- Falls Lake
- Lake George
- Lumsden Pond
- Holden Lake
- Card Lake
- Simms Settlement
- Holahan Lake
- Halifax Watershed
- Lewis Lake
- Upper Tantallon
- Cox Lake

UNIT 452: SHELBURNE GRANITE PLAIN

GEOLOGY AND GEOMORPHOLOGY

The Shelburne Barrens present a typical granite terrain, hummocky and covered with large boulders. The elevations are low, in keeping both with its position on the planation surface and also with the fact that the granite body is probably not fully exposed.

The surface has a mantle of thin stoney till with no drumlins.

SOILS

Soils in this Unit have developed from various parent materials - granite, quartzite, and schist. Large areas are poorly drained, either because of topography, shallow depth to bedrock, or the presence of a cemented ortstein layer. Sand plains are common. In the Yarmouth County corner of the unit Gibraltar, Bayswater and Aspotogan soils - all derived from granite - occur with patches of peat. In the rest of the unit poorly drained Bayswater and Aspotogan soils, and imperfectly drained Liverpool and Danesville soils, each often gleyed and mottled, are dominant on the largely level topography towards the coast, with some areas of better drained Medway, Mersey and Port Hebert soils where the relief is more pronounced.

VEGETATION

This unit is the most southerly portion of Nova Scotia which is not directly affected by the cold and fog associated with the Atlantic Coast. The growing season is hot and droughty on shallow soils. The natural vegetation appears to have been White Pine and Red Oak, but repeated burning has reduced many of the pine sites to a shrub cover of cinquefoil, Bearberry and Broom-crowberry, with scattered Black Spruce. Black Spruce predominates on ill-drained lands, while Red Oak covers the ridges. Hemlock and Red Spruce are found in the few unburned areas. The warm climate is indicated by the presence of plants which otherwise occur no further north than southern Maine, for example *Ilex glabra* and Inkberry.

FAUNA

The barrens do not provide productive wildlife habitat and this unit has the lowest small mammal diversity in the region, there being no more than four species commonly occurring. It does, however, support one of the best moose populations in western Nova Scotia.

SITES OF SPECIAL INTEREST

Many eskers along the shoreline, along Clyde River and north of Clements Pond.

UNIT 453: GRANITE RIDGE

GEOLOGY AND GEOMORPHOLOGY

The granite ridge along the Eastern Shore forms a prominent feature 50 miles (80 km) long and about 5 to 6 miles (8-10 km) wide. It rises sharply, sometimes with cliffs, to a narrow plateau 350 feet (100 m) above the Atlantic Coast Region.

The granite has been cut by faults in two places: one lies along the valley from Spider Lake through Lake Major, and the other lies along the Porter's Lake valley.

The Musquodoboit River also cuts across it in a narrow gorge and must have been superimposed by downcutting since the Cretaceous.

The surface of the granite has a thin veneer of coarse granite till which, at the eastern end of the ridge, is overlain with a few drumlins of red Lawrencetown till (Wolfville soils). These have spilled over from the area of the Eastern Shore Drumlins (435a) to the north.

SOILS

Gibraltar soils (well drained gravelly, sandy loams derived from granite) are dominant, with large areas of exposed bedrock, and small areas of imperfectly drained Danesville soil and peat bog.

VEGETATION

This Unit is somewhat cooler in summer than Unit 451 and has a climate quite similar to Unit 452. Red Spruce, Balsam Fir, birch, hemlock and White Spruce are common species on well drained sites. Black Spruce, Balsam Fir and Larch occur in wetter areas. Parts of the Unit are semi-barren. Scattered Red Oak occurs in the western part of the Lake Charlotte Sub-Unit. Intolerant hardwoods colonize burnt areas.

The ruggedness and effects of repeated burns, which still continue, are well described by C.D. Howe, writing in 1912. "The crests of the granite hills east of Halifax harbour have been deeply eroded by glacial action and have naturally very thin soils; and frequent fires have so exposed the rocks, that from a distance most of the rounded domes appear white. When not burned, they are sparsely covered by a black forest, that is, coniferous, in striking contrast to the lighter green of the hardwoods prevailing on the lower slopes. The higher slopes, especially when facing southward are covered with spruce overtopped by scattered white and red pine. The hardwoods go nearly to the top on the northerly-facing slopes. The low ridges usually support pure hardwoods. Red spruce prevails in the broader flats between the ridges, while hemlock predominates in the ravines and gullies, and at the base of steep slopes along the rivers and smaller lakes."

SITES OF SPECIAL INTEREST

Waverley Game Sanctuary
Provincial Parks and Park Reserves
- Paces Lake
- Caribou Lake

ASSOCIATED TOPICS

T12 Tertiary Drainage Patterns.

ASSOCIATED HABITATS

H14 Blanket and Raised Bog, H22 Maple, Oak, Birch Forest.

460 Bays

GEOLOGY AND GEOMORPHOLOGY St. Margarets Bay and Mahone Bay are ancient landscape features formed during a period of rapid erosion before the Carboniferous. During the Middle Carboniferous an extension of the Carboniferous sea transgressed this part of the old erosion surface and deposited limestone and evaporites. Most of these strata have now been eroded away and only a fringe is left around the margins of the two bays. Granite is the dominant rock-type in this District with slate forming a series of peninsulas on the west side of Mahone Bay.

The slates tend to be covered by fairly deep surficial deposits in the form of glacial tills and drumlins. The drumlin swarms continue into the sea, particularly in Mahone Bay where they form islands called "whalebacks". These have been extensively eroded by the sea in recent times to form shoals, spits and bars. Finer sediment is deposited in small salt marshes in the low energy environments at the heads of the bays. Small pocket sand beaches are present on exposed coasts at the bay heads but deep water, inland of sills at the bay entrances, has prevented the rising sea level from moving nearshore sand deposits onto the present coastline.

A coastal lowland developed on Carboniferous rocks around the bays is abruptly terminated by the steep sloping granite inland. On the Aspotogan Peninsula, which separates Mahone Bay from St. Margarets Bay, the till is very thin due to the scarcity of softer Carboniferous rocks.

SOILS (460a - Mahone Bay)
The soils around Mahone Bay are mostly derived from granite, quartzite and slate, with some Carboniferous material. Upper Blandford to East Chester is mostly Gibraltar soil with areas of exposed bedrock. Chester Peninsula, including the islands is mostly Bridgewater soil (sandy loam derived from slate). The remaining soils are a mixture of Bridgewater, imperfectly drained Danesville in flatter areas, well drained coarse textured Farmville (derived from a mixture of

granite, quartzite and slate), and Wolfville loams. There are a number of drumlins which are mantled by either Farmville or Wolfville soils. Most of the islands are Wolfville drumlins.

(460b - St. Margarets Bay)
St. Margarets Bay shows less variety of soil type than Mahone Bay. Gibraltar predominates with Rockland areas, and a few small patches of Wolfville soil.

VEGETATION The vegetation around both bays has been extensively disturbed, and is essentially a modified version of the coastal forest - mainly softwood, with Red Spruce, White Spruce and Balsam Fir.

FAUNA The coastal waters, particularly St. Margarets Bay, have been subjected to many oceanographic and biological studies during the late 1960s and 1970s. The deep basin of St. Margarets Bay, 250 feet (80m) is contained by a relatively narrow entrance with a sill at 120 feet (35 m) depth. Studies have shown the strong influence of slope water exchange on the supply of nutrients for biological productivity. During the spring phytoplankton bloom in late April the nutrient levels in the surface layer are depleted but subsequently partially replaced, during the summer and fall, by incursions of water from the continental shelf. These incursions of warm, nutrient-rich water stimulate periodic increases in phytoplankton production and bring adults and larvae of warm water animals (eg. flying fish, seahorse, blue crab) from the Gulf Stream. These species become conspicuous at times and may be taken in mackerel traps. In some years mackerel and tuna are abundant in the warm water of the bays.

The classic study sites of Stephenson and Stephenson (1954), describing intertidal zonation on rocky shores, are located at Peggys Cove and Mason's Cove in St. Margarets Bay.

The western shore of Mahone Bay, including the islands, has local importance for waterfowl and shorebirds. Waterfowl present at various times from spring through to early winter include Black Duck, Common Goldeneye, Oldsquaw, Scoter and Red-necked Grebe. Osprey are a common nesting bird on islands in this area.

SITES OF SPECIAL INTEREST	Provincial Parks and Park Reserves
	- Graves Island
	- East River
	- Second Peninsula
	- First Peninsula
	- Fox Point
	- Hubbards
	- Cleveland Beach
	- Queensland Beach

ASSOCIATED TOPICS

T6 The Carboniferous Basin: An Inland Sea, T21 Ocean Currents, T23 Oceanographic Environments, T25 Sea Level Change, T28 Offshore Bottom Characteristics, T52 Shorebirds.

ASSOCIATED HABITATS

H2 Open Water, H4 Boulder, Cobble Shore, H7 Salt Marsh, H32 Spruce, Fir-Maple, Birch (Coastal) Forest.

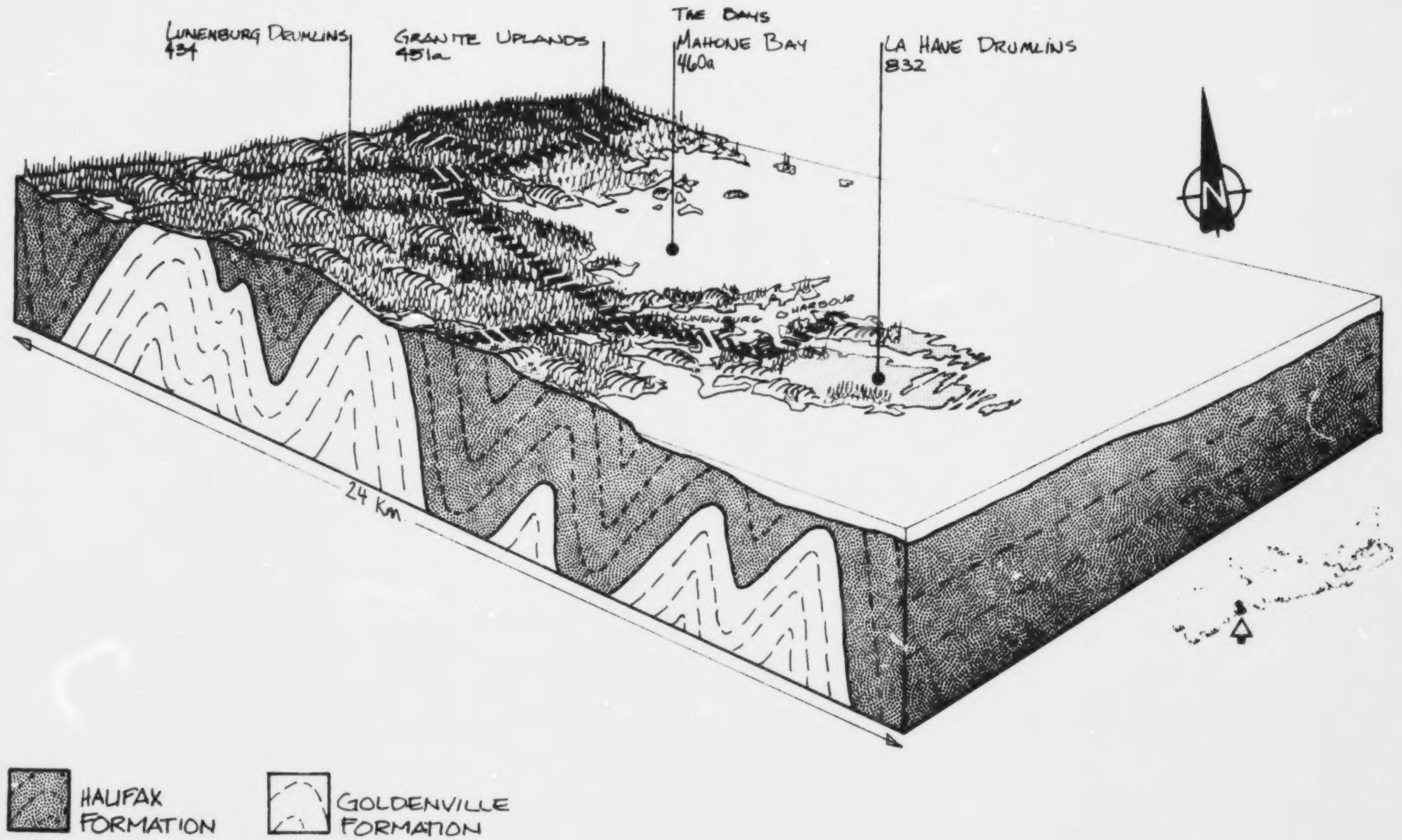
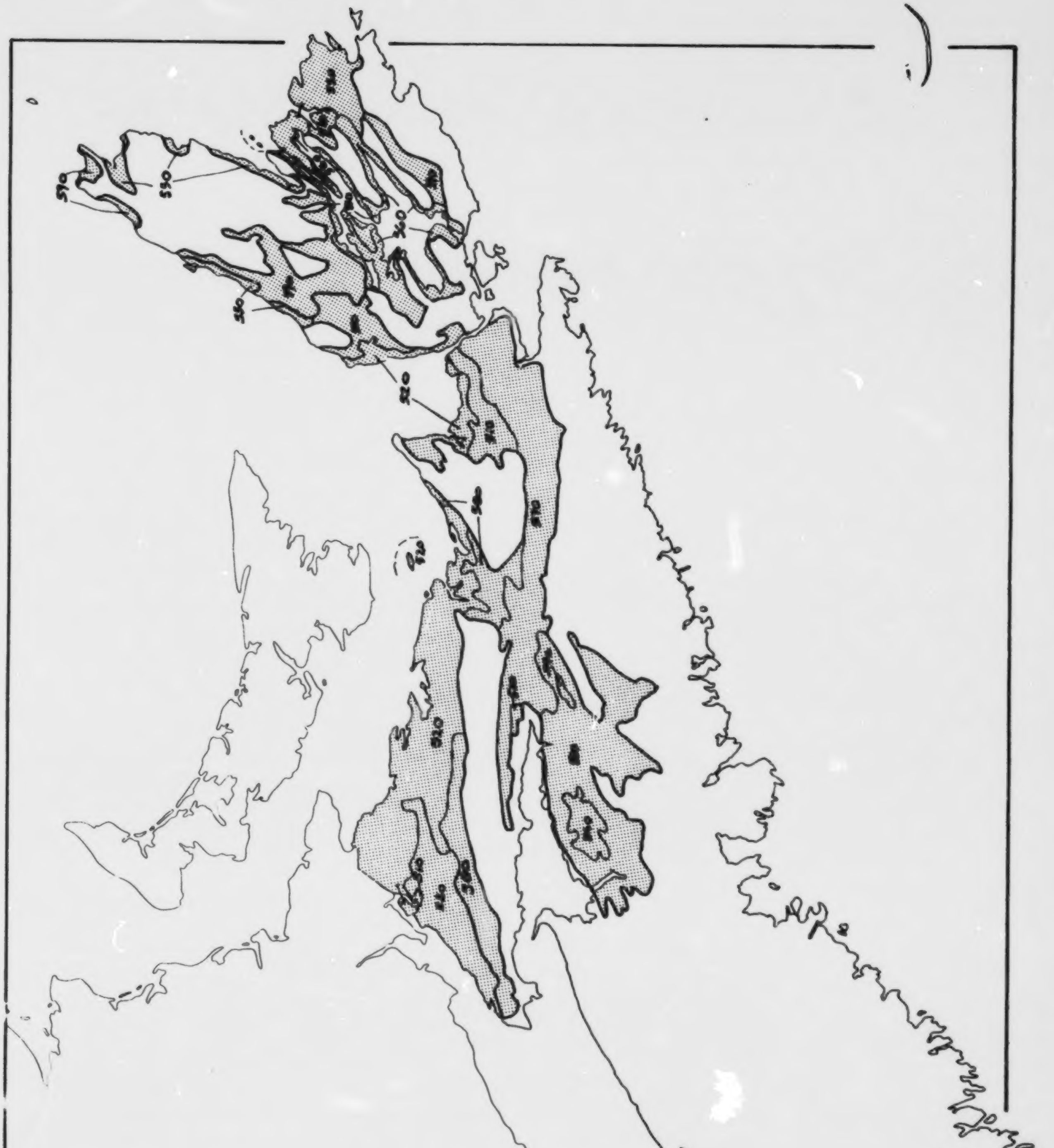

LUNENBURG DRUMLINS
434
GRANITE UPLANDS
451a
THE BAYS
MAHONE BAY
460a
LA HAVE DRUMLINS
832
LUNENBURG HARBOUR
N
24 Km.
HALIFAX FORMATION
GOLDENVILLE FORMATION

Plate 8. Mahone Bay

Drumlins cover the surface of the tilted planation surface as it dips beneath the Atlantic in this area. Many of the drumlins are composed of "red" tills (434) carried at least 60 miles (100 km) from the north. Erosion of drumlin islands and headlands has formed many shoals, some beaches and salt marshes in Mahone bay (460). Exposed slate headlands with scattered drumlins have a harsher climate resulting in coastal forest habitat (832).


510
530
560
520
580
520

500

500 CARBONIFEROUS LOWLANDS

REGIONAL CHARACTER-IZATION

Lowland Nova Scotia is mainly Carboniferous sedimentary rocks on which have developed deep soils. Many of the rivers flow in valleys eroded from the unresistant Windsor Group rocks which include gypsum. Horton Group sandstones are more resistant and form higher ground on the eastern mainland and on Cape Breton Island (District 510). Districts 580 and 590 abut the older upland blocks as foothills while the less resistant rocks of districts 520, 550 and 560 form coastal plains often with heavy soils. Flat lying sandstones and shales are ill-drained with numerous bogs (530 and 540) while the relatively infertile sandy soils derived from the resistant sandstones of district 570 cover a large area of central Nova Scotia.

GEOLOGY

The geological character of the area is best portrayed through a description of a) the palaeoenvironment in which the sediments accumulated and b) the processes which affected them after deposition.

The first deposits were coarse sands and grits (Horton Group) washed from the uplifted and folded Meguma Zone and the highland blocks of the Avalon Zone (Pictou-Antigonish and Cape Breton) into intermontane basins. In some areas these deposits were preceded by extrusions of lava as crustal adjustments continued to take place. The first basins were in the Pictou and Mabou-Antigonish areas but as sediments accumulated they became increasingly extensive. The early Horton deposits have no fossils and now form resistant bands shouldering the uplands. Later came deposits of silts and fine sandstones which contained abundant fish and plant remains. Towards the end of this period in the Early Carboniferous a marine incursion took place; the basins became enlarged and interconnected, and an inland sea formed with a shoreline on mainland Nova Scotia which closely approximates the present boundary of the Carboniferous deposits. Within this sea was an archipelago of islands including the Wittenburg Ridge, Mount Aspotogan, the Pictou-Antigonish Highlands, the elongated blocks of the Avalon Zone in Cape Breton, and the Cape Breton Highlands.

In the marine basin a laminated limestone formed followed by deposits of salts (mostly gypsum) and red and green shales. Near the islands shelly reefs developed, for example at Gays River, Aspotogan and East River (Mahone Bay). In the initial incursion of sea water the intermontane basins and much of the surrounding area was flooded. The limestone deposited at that time lays both on top of the Horton deposits and, where formerly dry land was covered, directly on the underlying topography. As the basin enlarged later deposits of Windsor rocks were laid directly on to the older rocks of the basin margin, as can be seen in Mahone Bay, St. Margarets Bay and on the eastern side of the Cape Breton Highlands. Windsor deposits attain a thickness of 1,500 feet (450 m) in the Shubenacadie area and up to 2,500 feet (750 m) in Cape Breton.

At the end of the Windsor period the land rose slightly and the sea withdrew to the east. Red and purple siltstones, shales and sandstones (Canso Group) were deposited in streams and lakes. The strata may once have been very extensive across Nova Scotia but now are found in only a few major areas, around St. Georges Bay, the Strait of Canso, Stellarton - Mount Thom and the Stewiacke Valley. They give red or purpleish soils and, when exposed on the coast (eg. Janvrin Island), bright red-coloured cliffs.

This period was relatively quiet, geologically; there were no tectonic upheavals and the topography was subdued. The Early Carboniferous deposits were by this time very thick and had buried the lower elevations of the terrain. Rivers developed wide valleys with broad floodplains and estuaries. Sediments deposited in the environment had been compacted to fine sandstones, black shales and thin coal seams (Riversdale Group). Again these strata may once have been very extensive but deep erosion has confined existing deposits to a few areas - a fringe around the Cobequid Hills, Pomquet, Port Hood, Broad Cove to Margaree Harbour, and Port Hawkesbury to St. Peters.

About this time conditions became suitable for the proliferation of fern-like swamp plants which flourished in extensive wetlands across the flat landscape. Great thicknesses of organic deposits accumulated and were compressed into coal (Cumberland, Pictou and Morien Groups). These Late Carboniferous strata, which are predominantly thick sandstones and shales, cover almost the entire area north of the Cobequids and about half of Cape Breton County. The major coalfields of Springhill, New Glasgow - Stellarton and the Sydney area are all in this group.

Carboniferous strata are relatively unmetamorphosed since, on a geological scale, they were never buried deeply. However they were affected by compressive crustal movements during the Permian and Jurassic periods. The most intensely affected area was a band across the northern part of the province from Chignecto Bay, through the Pictou coalfield and up through the Aspy Valley in northern Cape Breton. Resistant strata such as the Late Carboniferous sandstones and the Horton grits were thrown into open folds whereas the softer strata in the zone such as shales and gypsum were distorted and crushed. There was also movement along the Cobequid-Chedabucto and Aspy Faults with related movement along associated parallel and cross-cutting faults.

Carboniferous deposits accumulated to a depth of many thousand feet and engulfed most feastures of the old landscape. Since the Early Permian erosion has removed hundreds of metres of Late and Middle Carboniferous strata, has exposed the underlying Windsor and Horton group blocks, and has revealed ridges and valleys of the old erosion surface upon which these beds were deposited. A wide range of different rock types are now exposed with different responses to erosive forces. The topography reflects both this differential resistance, the structural character (folds and faults) of the area, and the relationship between the Carboniferous strata and the underlying rocks.

GEOMORPHOLOGY

The geomorphology within the Carboniferous Basin is variable. There are lowland plains, rolling uplands and coastal fringe areas. The lowlands fall into three main areas; the Windsor Lowlands (511) from the Avon River to the Stewiacke Valley; the Coastal Plain of the North Shore (520); and the Bras d'Or Lowlands (560) of central Cape Breton. These three areas are dominated by unresistant Windsor Group deposits which have been deeply eroded, in some places to well below present sea level. The rolling plains are underlain predominantly by the Late Carboniferous sandstones of Cumberland, Pictou and Morien Groups. They cover northern Antigonish, Pictou, Colchester and Cumberland Counties (521 and 532) and the area between Mira Bay and Great Bras d'Or Channel (531). The strata are fairly resistant and are moderately to strongly folded. In the Cumberland/Pictou area younger more easily eroded strata are exposed in the cores of the anticlines, consequently the landscape has developed a ridge and valley topography with moderate relief.

The upland areas are underlain by resistant Horton deposits. The rolling upland which lies between the Chedabucto and St. Marys Faults has been affected by folding and faulting to quite a degree yet it remains a rather featureless elevated area across the central mainland (570). This suggests that the topography reflects the more uniform resistance of the different rocks and therefore a similar response to the forces of erosion.

The Cape Breton uplands are underlain by Horton strata, inter-folded with Windsor deposits. A large area in Western Cape Breton exhibits strong relief and is varied and interesting. Windsor Group limestones and gypsum have been eroded to form the deep valleys occupied by the Baddeck, Middle and Margaree Rivers. Coastal fringe deposits skirt the Cape Breton Highlands and form narrow coastal plains at the base of steep cliffs (550). Resistant Horton sandstones form an upland plateau surface which these valleys dissect.

The intervening hilly areas of the Carboniferous Lowlands have topographic character transitional between lowland, plain and upland. Faults transect the Basins and often set strata of different resistance against each other. Downfaulted younger strata are set against older strata and are thereby preserved, for example, the Pictou Valleys (582).

Karst Topography

Throughout the Carboniferous Lowlands, in areas underlain by Windsor Group strata, pockets of gypsum and anhydrite (dehydrated gypsum) intersect the surface and produce a special feature called karst topography.

When anhydrite comes in contact with water it expands and changes to gypsum. Gypsum is readily dissolved by rainwater and, when it lies above the permanent water table, it crumbles and washes away leaving behind a small amount of reddish clay. Joints in the gypsum beds are enlarged and often subterranean channels are formed. Streams flow through these channels, sometimes enlarging them into caverns. If the roof of the cavern collapses a sinkhole forms; if the roof of a channel falls in, a long gully with vertical sides is left.

Often the ground over gypsum is so closely covered by pits that only narrow crumbling ridges exist at the surface. The depressions may be underlain by holes or channels and the whole area is treacherous to walk across.

Usually the groundwater in gypsum areas is heavily mineralized and the lakes and ponds are often saline. Streams are intermittent, disappearing into holes and channels only to reappear again some distance away.

A good example of karst topography exists at Amherst Point, another is found behind the Kings-Edgehill School in Windsor. Both locations have a number of sinkholes with the largest ones found at Windsor. Caves are rare but a well developed one called Hayes Cave occurs near South Maitland. This cave can be penetrated for 1,350 feet (400 m), has a miximum width of 200 feet (65 m) and a ceiling reaching 75 feet (22 m).

DRAINAGE

In general, strata of the Carboniferous Basin are moderately to highly permeable. Rivers and their tributaries tend to follow fold axes and joint directions, and often exhibit a rectangular pattern. Most of Nova Scotia's major flood plains or intervales are found on the larger, mature rivers of this Region. These include the Margaree in Cape Breton, the East River of Pictou, Stewiacke, Musquodoboit and rivers draining north from the Cobequid Hills such as the Phillip. Karst topography has developed on the gypsum with the classic pattern of intermittent streams, and sinkholes. Overall there are few lakes, except where glacial deposits have impeded drainage, and the drainage pattern has a relatively low density of streams. Exceptions are the very flat heavy clays of the Scotch Village Barrens in which drainage is very slow and on which extensive peat bogs have formed (district 540) and the very flat isthmus by which Nova Scotia is joined to New Brunswick (unit 523).

CLIMATE

The Carboniferous Lowlands form a large, scattered Region and within it the climate shows considerable variation, although it is essentially an inland lowland climate characterized by cold winters and warm summers. The major modifying influences are elevation in Cape Breton, marine influence from the Gulf of St. Lawrence, the Bras d'Or Lake, and the Atlantic Ocean.

Winters are cold, though not severe. January mean daily temperatures are less than 43°F (6°C). Because of the influence of the Atlantic, fall temperatures in the Sydney area are somewhat higher. Spring comes later to those areas near the coast because of the ice cover and persistent cold water. Mean daily temperatures rise above freezing before the end of March and the growing season is underway before the end of April. Spring is also later at higher elevations. Temperatures warm up quickly on the mainland, but stay cool in Cape Breton and along the coast of the Gulf of St. Lawrence because of cold winds off ice-covered waters.

By July the whole Region has warmed to a mean daily temperature over 63°F (17°C). Mean daily temperatures less than 32°F (0°C) return in November in the mainland interior, and in early December in the rest of the Region.

The total annual precipitation varies through the Region. In general it is drier towards New Brunswick, where parts of the Northumberland Plain (521) receive less than 40 inches (1,000 mm), and wetter in Cape Breton which receives 48 to 64 inches (1,200-1,600 mm). Snowfall is heavy in the interior and in the dissected plateau (590) of Cape Breton, but lighter near the coast. The snow cover season lasts in excess of 130 days, in all areas except northern Cape Breton and parts of the mainland interior where it can exceed 140 days.

Early spring fogs are a feature along the Northumberland Strait because of the influence of the cold sea water on warm winds. The frost-free period is under 100 days in the interior, but lengthens to 140 days or more along the coast and around Sydney. The number of accumulated growing degree-days is high, particularly along the North Shore where the warm summer waters of the Northumberland Strait boost summer temperatures.

SOILS

The main factors affecting soil development in this Region are the great variety of rock types and landforms; the generally more erodable nature of the rock; and the varied hardwood and softwood vegetation. There is considerable variation in the soils which form a more intricate soil mosaic than is found in Regions such as the Atlantic Interior. The tills tend to be deep and the soils that have developed on them are often heavy textured with impeded drainage. Lowland soils usually have fewer stones and are more readily compacted. As elsewhere in the province Humo-Ferric Podzols cover major areas, but Luvisols, Brunisols, and Gleysols are well represented. Sandy loams occur on the Horton and Pictou-Morien formations, while shaly loams occur on the Windsor, Riversdale and Canso formations. Extensive regosols have developed on alluvial materials especially in the larger river valleys, common in this Region.

Gypsum areas are usually overlain by glacial tills rather than by soils developed in situ, and exhibit a variety of soil types. However, because some gypsum has usually mixed into the tills the local soil is often improved in terms of structure and permeability. For this reason, the soils in gypsum areas are usually well-drained, even when otherwise fine-textured. The soils are also less acid because of the influence of the gypsum. One type of soil that is commonly associated with gypsum is the Falmouth series, developed from a clay loam till deposited over gypsum. While Falmouth soils can be important for agriculture, when they occur over gypsum their use is often limited by the sink hole (karst) topography.

VEGETATION

The Carboniferous Lowlands spread over three of Louck's forest zones. One zone is dominated by softwoods while in the other two, which are more northerly, semi-upland zones, hardwoods are more prominent. The Windsor Lowlands and the Northumberland Plain fall within the Red Spruce-Hemlock-Pine zone. The Antigonish, Guysborough and Bras d'Or areas are in the Sugar Maple-Hemlock-Pine zone, and the higher Dissected Plateau districts of Cape Breton are in the Sugar Maple-Yellow Birch-Fir zone.

The main influences on the Regional vegetation are the warm summers and cold winters; heavier soils; and extensive disturbance through logging, fire and farming. The Windsor Lowlands near Windsor and Truro grow mostly softwoods - Red Spruce, Black Spruce, Balsam Fir, Red Maple and Eastern Hemlock. On the Northumberland Plain where landforms are level and drainage is often poor, Black Spruce, Red Spruce and fir are the most common species, sometimes forming mixedwoods with pine, Red Maple or the tolerant hardwoods. In Cape Breton White Spruce and Balsam Fir dominate the lowlands, while Red Maple, White Birch and Yellow Birch become more common on the hilly lands. On the higher ground near Lake Ainslie, better drainage and cooler summers result in larger numbers of tolerant hardwoods.

In general bogs are not as prominent a feature as in the areas of more impermeable bedrock, but they are still common in the Windsor Lowlands, Bras d'Or and Sydney areas. Saltmarshes and freshwater marshes are abundant. Rich intervale lands in central mainland areas and in Cape Breton Island often provide habitat for rare or unusual Alleghenian plant species.

The vegetation of gypsum areas is influenced by the calcareous nature of the soils, the dryness of the soil, and by the karst topography which limits disturbance through forestry and agriculture. The main form of disturbance associated with gypsum is mining, but this is now mostly confined to deep, unweathered deposits, and areas with gypsum outcrops and cliffs are more likely to be left untouched. Mixed forest (often including Hemlock, Red Spruce and Red Oak) is interspersed with bare scrubby areas where the soil is too thin and dry to support tree growth.

Botanical interest is provided by a number of rare or unusual plants which survive in gypsum areas because of the comparative lack of competition. The flowers are best in the early spring, before the soil becomes parched. On the crumbling cliff faces can be found Bird's-eye Primrose and the Fleabane Engeron hyssopifolius. At the top of the cliffs Gypsum Ragwort often grows, and beneath the trees American Dog-violets and Yellow Lady's-slippers can be found. After these flowers are finished several hardy shrubs remain - Round-leaved Dogwood, Shepherdia canadensis, and Shrubby Cinquefoil. Some of these plants require basic soils while others (Cinquefoil and Yellow Lady's-slipper) can also be found in acid bogs, where the mechanisms to reduce evaporation, which are so necessary on the dry gypsum, help to prevent the plant from being poisoned by excessive take-up of acid water. Rarities occasionally found in gypsum areas include Leatherwood, and the Ram's Head Lady's-slipper.

FAUNA

This Region provides a diverse mix of open land, oldfield, and forest habitats. There are few lakes of much size, but many wide, slow moving rivers. Deeper soils and level terrain result in numerous productive freshwater marshes. Along the North Shore the gentle slope of the shoreline gives important intertidal habitat even though the tidal range is small.

Small mammal diversity ranges from low (coastal marshes) to high (Ainslie Upland) depending upon habitat. In agricultural areas an open land mammal fauna is found; fox, raccoon and skunk. In the wilder, less accessible parts of the region moose, deer and some bear can be found. Muskrat and mink are plentiful along streams and rivers. The gypsum provides calcareous soils which support the greatest diversity of land snails found in Nova Scotia. The caves in gypsum provide hibernating sites for bats. Productive aquatic habitat supports a more diverse freshwater fauna than is found elsewhere in the province.

In the Gulf of St. Lawrence the warm summer water temperatures permit the existence of disjunct populations of Virginian marine fauna. The Bras d'Or Lake has an impoverished marine fauna.

This region provides important habitat, both freshwater and coastal, for waterfowl.

The Region has been divided into districts on the basis of topographic character and soil type. They are as follows:

510	Till Plain
520	Coastal Plain
530	Stoney and Wet Plain
540	Clay Plain
550	Coastal Fringe
560	Submerged Lowland
570	Rolling Upland
580	Hills and Valleys
590	Dissected Plateau

ASSOCIATED TOPICS

T6 The Carboniferous Basin: An Inland Sea, T10 Land-based Economic Deposits, T11 Development of the Ancient Landscape, T12 Tertiary Drainage Patterns, T20 Nova Scotia's Climate, T29 General Hydrology, T31 Soil Development and Soil Climate, T43 Plant Communities in Nova Scotia, T45 Successional Trends in Vegetation, T47 Rare Plants, T49 Forest and Open Habitat Birds, T51 Wetland Birds and Waterfowl, T54 Mammals, T56 Ungulates, T59 Lands and Freshwater Invertebrates, T63 Marine Invertebrates.

ASSOCIATED HABITATS

H5 Sandy Shore, H7 Salt Marsh, H8 Coastal Fresh marsh, H10 Freshwater Pond, H12 Slow-moving Stream, H18 Oldfield, H21 Cave, H23 Spruce, Fir, Pine Forest, H25 Spruce, Hemlock, Pine Forest, H27 Sugar Maple, Yellow Birch, Beech Forest, H34 Red Maple, Elm (Floodplain) Forest.

510 Till Plain

GEOLOGY AND GEOMORPHOLOGY

Across central mainland Nova Scotia is a large area characterized by the close interrelationship of underlying, resistant, Horton Group Strata and overlying, less resistant, Windsor Group limestone, salts and shales.

The large rivers that flow across this area follow fault lines or the courses of ancestral rivers, for example, the Avon and Shubenacadie. However their tributaries tend to flow northeast or southwest in synclinal hollows between anticlinal ridges.

The Carboniferous strata were readily eroded by glacial action during the last ice age and the district is heavily blanketed by glacial debris. Outwash deposits are common.

District 510 has been divided into two widely separated units each of which has a distinctive topographic character:
511 Windsor Lowlands
512 Salmon River Lowland

UNIT 511: WINDSOR LOWLAND

a) Shubenacadie River
b) East Mountain

The Windsor Lowland covers a very large area south of the Minas Basin from the Avon River east to the Shubenacadie and Stewiacke River Valleys (511a), and a small area north of Truro (511b). These two areas are part of the same depositional area and have the same characteristics.

GEOLOGY AND GEOMORPHOLOGY

The southern boundary of Unit 511a against the Atlantic Interior is essentially identical with the shoreline of the Carboniferous depositional basin in this part of Nova Scotia. The Horton deposits range in thickness from zero at the margins to nearly 3,300 feet (1,000 m) near North Mountain. The Wittenburg Ridge was an upland at the time of deposition and the Horton deposits thin out on its flanks. It is evident that the Rawdon Hills were not upland because the same thinning does not occur. Good exposures of Horton strata are found at Victoria Park, Truro and at Horton Bluff where fossiliferous middle Horton sandstone and shales outcrop. During the period in which deposition was taking place from the Windsor sea, reefs formed near the shoreline. One of these, north of the Wittenburg Ridge, is at Gays River; others are found on the Atlantic Coast at East River and Aspotogan where they developed in another arm of the sea which extended to Sable Island.

The Windsor Group deposits are about 1,400 feet (425 m) thick and overall consist of about 50 percent shales and 25 percent each of limestones and gypsum. Gypsum occurs in deposits massive enough for commercial exploitation in several localities. At Dutch Settlement (Hants County) the gypsum beds are 200 feet (60 m) thick. One billion tonnes have been blocked out and another four billion are in reserve. In the Windsor area gypsum is extracted at Miller Creek and Wentworth Creek. From Windsor to Brooklyn white cliffs of gypsum can be seen from the road. A wide area of gypsum is preserved in the Cheverie syncline.

Another commercial operation is at Upper Musquodoboit where dolomite (magnesian limestone) is quarried for agricultural purposes.

Overall the landscape has low elevations and little relief. The Avon River cuts across low ridges with intervening valleys occupied by its tributaries. Halfway River and the Cogmagun River flow into the Avon estuary from west and east sides respectively. The Upper Avon, Kennetcook and St. Croix lie parallel on either side of the estuary. Overall the river system has a rectangular pattern. The lower part of the river valley has been drowned forming a wide estuary which extends into the tributary rivers. The red silt that forms the wide mud banks within the river is carried in from the Minas Basin and is derived from erosion of the Triassic deposits. The upper courses of these rivers flow in wide meanders across the lowland bordered by salt marsh and meadows. The Avon River itself may occupy a similar course to its ancestral river which, it is hypothesized, flowed northwards from the southern uplands during the Cretaceous.

The Shubenacadie River, like the Avon, cuts across the fold axes and bands of hard and soft strata reaching Cobequid Bay west of Truro. At its mouth a narrow band of Horton rocks overlain by Windsor limestone can be seen at Black Rock. For the next five kilometres inland it cuts through soft red sandstone containing bands of fibrous gypsum. At Eagles Nest (north of the Maitland Bridge) the river cuts a narrow channel through a faulted block of coarse Horton grits. To the south a cliff of gypsum is exposed at Big Plaster Rock. Further up the river, passing more grits and red sandstone, a fossiliferous limestone containing corals and shells is exposed at Anthony's Nose.

The Stewiacke River, a major tributary of the Shubenacadie River, flows parallel to the fold axes. The relief and altitude in this area is so low that neighbouring streams flow for long distances in opposite directions. (for example, the South Branch flows northeast following a narrow bed of Windsor group rocks while the Stewiacke flows southwest).

The mantle of glacial till attains a thickness of 250 feet (75 m) near Stewiacke. At Dutch Settlement spruce branches have been found under the glacial till which date back to the Wisconsin glaciation 18,000 years ago. A large outwash deposit is found south of the Shubenacadie Indian Reserve and is known as the Hardwood Lands Aquifer. It is a significant fresh water resource in an area of saline groundwater. Sands and gravels are seen in many locations including the Stewiacke River and its South Branch, and at Hilden south of Truro.

SOILS

(Unit 511a - Shubenacadie River
A considerable variety of soils is found in this area, but the dominant series is Queens, an imperfectly drained sandy clay loam developed on clay loam till derived from shale and sandstones. Well drained Hansford sandy loams have developed on Horton sandstone in the Hantsport-Walton area. Mottled Hantsport soils, again from shales and sandstones, are found in low-lying areas and close to the coast. Drumlinoid features are common from Brookfield to Enfield, and lacustrine deposits often occur on the till plain. Alluvial soils such as Stewiacke, Cumberland and Chaswood often occur along stream and river valleys. These range in texture from gravelly sandy loams to silty clay loams.

(Unit 511b - East Mountain)
The main soil series in this sub-unit is Diligence - an imperfectly drained clay loam over clay till derived from grey shales. Along North River, Cumberland gravelly sandy loams occur.

VEGETATION

The main factors influencing the vegetation of this Unit are the gentle relief, poor drainage and the repeated cutting and burning of the forests. The spruces, fir, White Birch, Red Maple, Hemlock and White Pine are the major species, with scattered Sugar Maple, Beech and Yellow Birch occurring on better drained low ridges. Abandoned farmlands are common and these have usually been re-colonized by White

Spruce, Red Spruce and Balsam Fir. In other areas repeated burning has encouraged Wire Birch, White Pine, Red Pine and Black Spruce. Repeated disturbance sometimes leads to the development of semi-permanent shrub cover. White Elm, Black Ash, and occasionally Sugar Maple and beech may be found along the river systems.

C.D. Howe made the following observations on soil-forest relationships of this area in 1912. "Along the coast, the ridges are capped with hardwoods and the depressions support a mixed forest in which either red spruce or hemlock prevails; and frequently, the conifers occur in pure stands. The mixed forest is very luxuriant on the broad gentle slopes where the composition is from one-half to three-fourths red spruce and usually about 15 percent is yellow birch and five percent beech. The soil is deep and consists mostly of silt and fine sand. When the top of the ridges are narrow they are crowned with hardwoods, otherwise the mixed type extends over them."

FAUNA

This Unit offers a mix of lowland, disturbed forest habitats, scattered farmlands, dykelands, salt marsh, and fertile river valleys. There are few lakes, but the rivers and streams are comparatively productive. The Unit provides good habitat for raccoon, muskrat, and mink, and diverse breeding habitat for waterfowl. Concentrations of wintering bald eagles are found along the Shubenacadie River where Common Merganser and Black Duck also over-winter. Wood Turtles are abundant in the Musquodoboit Valley. The freshwater fauna is diverse.

SITES OF SPECIAL INTEREST

Avon River Area

Horton Bluff (north of Hantsport)
- fossil plants, inverteberates, fish, amphibian bones and tracks (including the largest footprints of this age ever reported)

Newport Landing (northeast of wharf)
- good exposure of early Windsor Group fossiliferous limestone containing brachiopods, gastropods, bryozoans, cephalopods, and pelecypods. This is succeeded by gypsum, limestone, shale, sandstone.

Cheverie (Near Mutton Cove)
- late Horton age trees stumps 4-8 inches (10-20 cm) high and 4-12 inches (10-30 cm) in diameter.
- Karst topography

Cheverie Point to Summerville
- Horton age soil beds with rootlets.

Wolfville to Windsor (along Highway 101)
- road runs along the Wolfville Ridge (anticline) with the Gaspereau syncline to the south.

Hantsport
- road descends into the syncline of Halfway River and up the slope of the next anticline (Grey Mountain).

Brooklyn
- in a gypsum area to the west Yellow Ladys Slipper, Shepherdia and _Carex_ _flacca_ are found.

Gypsum Areas: Karst Topography
- Cheverie
- Walton through Goshen to Lower Burlington
- Mount Denison to Windsor Forks to Newport Corner
    - gypsum cliffs along the St. Croix River
    - sinkhole behind Kings-EdgeHill School.

Shubenacadie River Area

*Black Rock (mouth of Shubenacadie)
- Horton strata overlain by Windsor limestone.

*Eagles Nest
- Horton sandstone.

*Big Plaster (White's) Rock
- gypsum cliff

*Anthony's Nose
- fossiliferous limestone, 50 feet (15 m) thick, containing shells and corals.

Victoria Park (Truro)
- steeply inclined Horton sandstone and siltstone.

NOTE: *along the Shubenacadie River

Gypsum areas: Karst Topography
- Urbania (south of Maitland)
- South Maitland (Hayes Cave)
- Lantz

Shubenacadie (IBP Proposed Ecological Site 68)
- clear-cut in mixed woods, regenerated with Leatherwood (Dirca palustris); Carex aurea; Millium effusum var. cisatlanticum; Cystopteris bulbifera; Rhamnus alnifolia.

St. Croix River (IBP Proposed Ecological Site 66)
- mixed forest on karst topography harbouring rare orchids.

South Maitland (IBP Proposed Ecological Site 69)
- river intervale, gypsum cliffs, mixed forest and cave system.

Provincial Parks and Park Reserves
- Shubenacadie Wildlife Park
- Smiley's
- Musquodoboit Valley
- St. Croix
- Cheverie
- South Maitland

ASSOCIATED TOPICS

T26 Coastal Landforms, T47 Rare Plants, T50 Birds of Prey, T58 Amphibians and Reptiles.

ASSOCIATED HABITATS

H6 Mud Flat, H7 Salt Marsh, H12 Slow-moving Stream, H19 Cliff, H21 Cave.

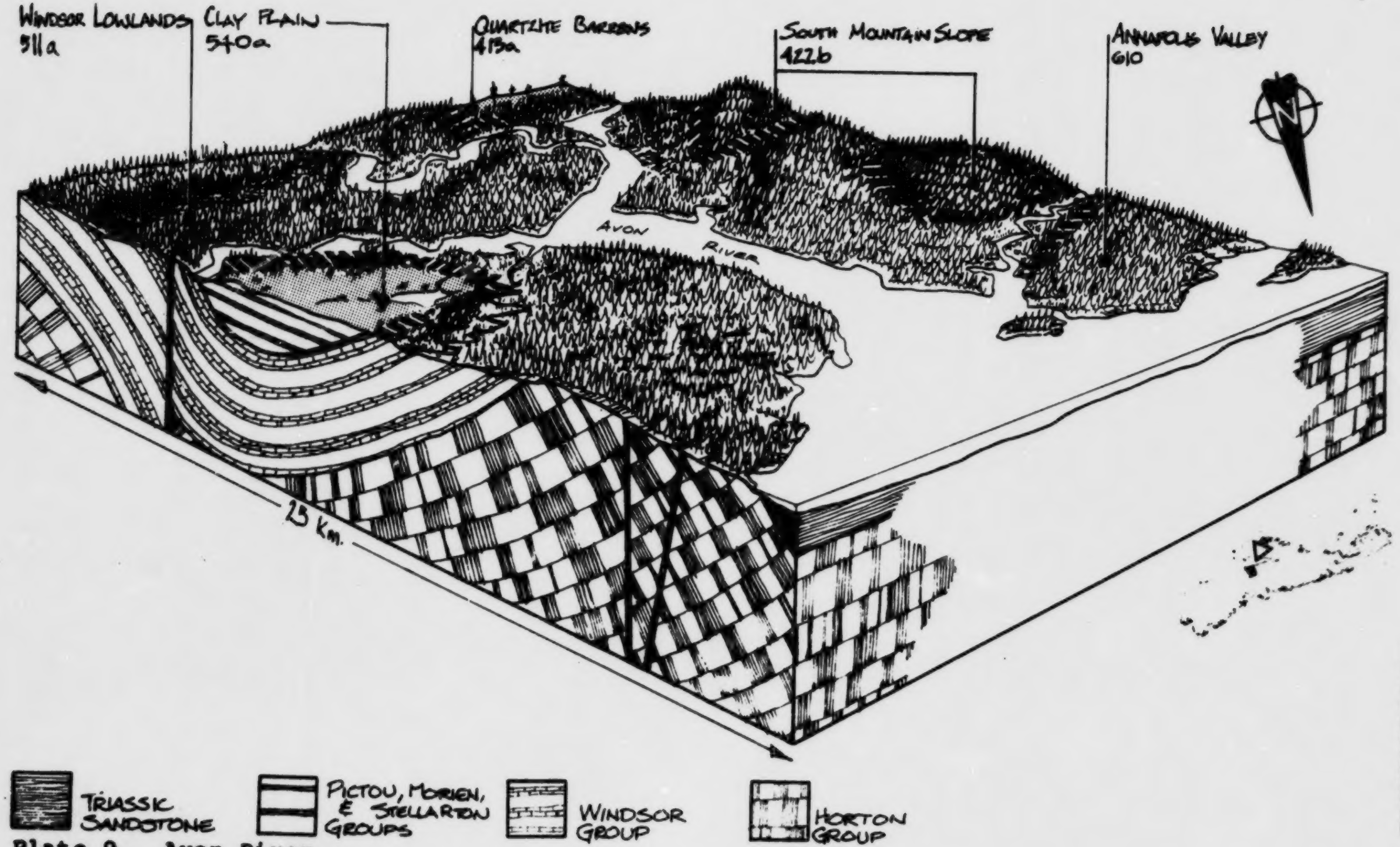

WINDSOR LOWLANDS
511a
CLAY PLAIN
540a
QUARTZITE BARRENS
413a
SOUTH MOUNTAIN SLOPE
422b
ANNAPOLIS VALLEY
610
N
AVON
RIVER
25 Km.
TRIASSIC SANDSTONE
PICTOU, MORIEN, & STELLARTON GROUPS
WINDSOR GROUP
HORTON GROUP

Plate 9. Avon River

Rising sea level has drowned the Avon River estuary which drains the Windsor Lowlands (511). The river cuts through the resistant Horton Group sandstones between high banks but wherever unresistant Windsor Group rocks are encountered wide valleys have been excavated. Extensive karst topography developed on gypsum (part of the Windsor Group) is prominent. In the background, uplands of the Atlantic Interior define the Avon River drainage basin (413 and 422).

UNIT 512: SALMON RIVER LOWLAND

GEOLOGY AND GEOMORPHOLOGY

South of the East Bay Hills a large wedge of Late Carboniferous sandstone has been downfaulted between blocks of ancient Avalon Zone strata. This is the Salmon River Lowland. The elevations are low in this part of Cape Breton, being on the low side of the tilted planation surface, and the area has been thickly covered by glacial deposits.

The Salmon River has been impounded by ridges of glacial debris to form Loch Lomond, Lake Uist and Lake Enon, which lie just to the south of the area. Another deposit, oriented north and south, divides a small lake into two at the northern end of the lowland.

In general the terrain is low and rolling with few elevations greater than 330 feet (100 m).

SOILS

Shulie soils (well drained sandy loams) cover much of this unit. Around Rock Elm, to the north of the unit, there is a small area with complex soils - clay loams such as Millbrook and Kingsville, and alluvial soils such as Cumberland and Millar. Near Gaspereaux Lake, in an area known as the Big Barren, poorly drained Arichat and imperfectly drained Debert soils occur, with better drained Woodbourne soils derived from a gravelly clay loam till. Around the Loch Lomond lakes the soils are mostly imperfectly to poorly drained, usually sandy or silt loams over compact clay tills such as Millbrook, Woodbourne, Masstown, Debert and Kingsville soils.

VEGETATION

This Unit is transitional between Louck's Coastal Forest (H.32) and the Sugar Maple, Hemlock, Pine Zone. Intolerant hardwoods (H.22) also occur with scattered tolerant hardwoods. The compact clay soils support mostly Balsam Fir with lesser amounts of White Spruce. Intolerant hardwoods with aspen and a few beech grow on the better drained slopes.

SITES OF SPECIAL INTEREST

Provincial Parks and Park Reserves
- Two Rivers

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits.

520 Coastal Plain

GEOLOGY

District 520 of the Carboniferous Basin is one of the three true lowland areas of Nova Scotia; the other two are the Windsor Lowland (511) and the Submerged (Bras d'Or) Lowland (560). This District borders the Northumberland Strait (with one interruption) from Tidnish to Port Hood. It is underlain by Middle and Late Carboniferous strata (Windsor to Pictou Groups) which are all unresistant. Consequently the relief is low, and the topography is flat and undulating. This area is also submergent so there are many long inlets and estuaries extending inland from sheltered harbours.

The District is divided into three units:

521 Northumberland Plain
522 Judique Coastal Lowland
523 Tantramar Marshes

UNIT 521: NORTHUMBERLAND PLAIN

The Northumberland Plain unit is divided into two areas:
a) Northumberland Strait
b) St. George's Bay

GEOLOGY AND GEOMORPHOLOGY

521a) Northumberland Strait

This coastal plain which stretches from the Cumberland Basin to Pictou and Merigomish Island is underlain by the fine red sandstones of the Late Carboniferous Pictou Group (from Merigomish to Knoydart, Canso strata predominate). These sandstones have been thrown into broad folds. In Cumberland County there are two main anticlines: one runs from Pugwash Harbour west to Nappan, Amherst Point and the area south of Minudie; the other runs from Malagash Point past Oxford then plunges downward east of Springhill. The crests of these anticlines have been partially eroded away exposing underlying Windsor evaporites or Canso Group strata. Gypsum outcrops in many places, there are brackish lakes at Oxford and salt springs between River Phillip and Springhill. Salt deposits at Malagash were mined for 40 years and the salt mine at Pugwash is still productive. Deposits up to 1,500 feet (450 m) thick have been drilled in this area.

In addition to the two main anticlines there are many minor folds which run east-west before plunging downwards. Differential erosion has created ridges and valleys parallel to the fold axes creating an undulating landscape. In central Cumberland county they rise to 400 feet (120 m) or more, for example Streets Ridge east of Oxford.

Alternating low ridges and valleys determine the outline of the coast along Northumberland Strait. The ridges run out to sea as headlands at Pugwash and Wallace and nearly enclose Tatamagouche Bay and Amet Sound. Smith Point, Malagash Point and Cape John are prominent projections; Caribou Island is a continuation eastwards of the Pictou County shore; and Pictou Island is a remnant of a ridge which existed in the centre of the Northumberland Strait.

Valleys form inlets and harbours along the coast where estuaries of the river became drowned by a rise in sealevel.

Lakes are infrequent on this coastal plain and where they occur (except on gypsum) are elongated and shallow. The streams flowing over the lowlands east of Amherst lie in an area of gentle topography, branching irregularly to form dendritic drainage patterns. Streams flowing northwards from the Cobequids have been superimposed on bands of alternating weak and resistant strata. The Wallace River, for example, flows directly north from Folly Lake. Its tributaries are adjusted to bands of weaker rocks and join it at right angles so that a trellised drainage pattern has formed. Similarly River Phillip and River Hebert have tributaries adjusted to the strike of the strata.

At the eastern end of the Cobequid Hills the strata have been domed up as the once underlying crustal block of the Cobequids rose upwards. Consequently due west from Pictou progressively older rocks are exposed - Early Carboniferous to Late Devonian to Middle Devonian. These strata become progressively more resistant and form a hilly upland projection at the eastern end of the Cobequids (320).

From Merigomish to Knoydart the Northumberland Plain continues as a submerged rolling coastal lowland.

521 b) St. George's Bay

Middle Carboniferous strata, (Windsor, Canso and Riversdale) underlie a lowland on the south side of St. George's Bay. Elevations rarely exceed 160 feet (50 m). Fine red Canso and grey/brown Riversdale sandstones and siltstones predominate with a faulted block of Windsor evaporites exposed east of Antigonish. This band of Windsor strata has been eroded and drowned to form Antigonish Harbour. In places, where gypsum outcrops, karst topography has developed. At Crystal Cliffs to the north a 250 foot (75 m) high cliff with bands of white and pink gypsum faces the Bay.

On the south side of St. George's Bay several harbours have been created from drowned river valleys cut into Carboniferous rocks - Pomquet, Tracadie, Little Tracadie and Havre Boucher.

Throughout the area there is a variable but ubiquitous cover of glacial till. Eskers and outwash material are found along River John and elsewhere where rivers carried melt water from the ice cap over the Cobequids.

SOILS

The sandstones and shales which underlie the entire area have produced glacial tills of a sandy loam to sandy clay loam texture. One common characteristic is the tight, impermeable nature of the subsoil. This effectively prevents rapid vertical movement of water which must therefore be removed laterally, or through evapotranspiration. The most common soils are Debert, an imperfectly drained sandy loam often with fragipan development, and Queens, a fine textured imperfectly textured sandy clay loam. Well drained soils include Pugwash and Tormentine series on rolling topography. Kingsville and Masstown Series occupy most of the poorly drained sites. Hebert soils on outwash materials, Cumberland and finer textured Chaswood soils on alluvial materials, are common along streams and rivers.

VEGETATION

This Unit falls within the Maritime Lowlands Ecoregion of Louck's Red Spruce - Hemlock - Pine zone. Black Spruce, Jack Pine, White Spruce, Red Spruce and Red Maple are the most abundant species, although Hemlock and White Pine are not uncommon. Hemlock occurs in pure stands throughout and is often among the first species to colonize disturbed areas. Larch and Black Spruce (H.33) occur in the extensive boggy areas. Beech and Sugar Maple are found on a few slopes near the larger streams. Repeated fires have encouraged Jack Pine (H.28), especially around Oxford. Poplar was once widespread on burned areas to the east, but these are now being replaced by conifers although large amounts of poplar remain. Much of the area is farmed and oldfields generally re-colonize in alders followed by White Spruce. Larch more commonly colonizes wet fields underlain by fragipan along the coast.

Winds from the Northumberland Strait, often recorded at twice the speed of winds at inland stations, are a strong influence. Trees often lean away from the wind, have one-sided crowns, and do not attain full height, a phenomenon known as "krummholz". Extensive salt marsh and Eel Grass beds occur in bays.

FAUNA

This Unit provides mostly oldfield, agricultural and softwood forest habitats. It is an excellent area for muskrat, mink and raccoon, and provides average habitat for Red Fox. Freshwater habitats are relatively productive and support an enriched fauna, including the Brook Stickleback. Important waterfowl breeding and migratory staging areas are found along the coast because of the extensive intertidal areas formed by the very shallow slope of the sea bottom. The most important area is around Fox Harbour, Wallace Harbour, Tatamagouche Bay, Brule Harbour and John Bay, where large numbers of ducks and geese congregate in late March and April, and again in September until ice forms in December. Other important areas include Coldspring Head and the mouth of the Shinimicas River; Pugwash Harbour and River Philip; Caribou Harbour; Pictou Harbour, East River, Middle River and West River; and Little Harbour and Merigomish Harbour. Bald Eagle and Osprey breeding habitat occurs in this area, and Piping Plover breeding sites are found in some of the larger sand beaches.

The Northumberland Strait is a very distinct marine area in which warmer water species such as oysters and quahogs are found.

SITES OF SPECIAL INTEREST

Crystal Cliffs
- 250 feet (75 m) cliff with bands of pink and white gypsum

Antigonish Harbour
- drowned estuary; karst topography

Pugwash

Malagash
- salt mines

Oxford
- round water-filled sinkholes make small lakes

Streets Ridge (400 feet (120 m) high)
- brackish lakes

Amherst Point
- sinkholes

Laytons Lake
- very productive freshwater marsh

National Wildlife Areas
- Wallace Harbour

Provincial Wildlife Management Area
- Antigonish Harbour
- Amherst Point Bird Santuary

Black River Road (IBP Proposed Ecological Site 6)
- Jack Pine Forest.

Provincial Parks and Park Reserves
- Tidnish Dock
- Black
- Northport Beach
- Heather Beach
- Gulf Shore
- Fox Harbour
- Tatamagouche
- Barachois Harbour
- Balmoral Mills
- Shinimicas
- Rushton Beach
- Cape John Beach
- Waterside Beach
- Mackenzie Beach
- Doctor's Island
- Caribou
- Lyons Brook
- Boat Harbour
- Powell's Point
- Melmerby Beach
- Merigomish Harbour
- Big Island
- The Ponds
- Mahoneys Beach
- Pomquet
- Bayfield
- Barrios Beach
- Cape Jack Beach

ASSOCIATED TOPICS

T13 Glaciation, T23 Oceanographic Environments, T25 Sea Level Change, T34 Biological Environment, T35 Hardpans, T60 Freshwater Fishes.

ASSOCIATED HABITATS

H1 to H7 Marine Habitats, H10 Freshwater Pond, H12 Slow-moving Stream, H18 Oldfield, H28 Pine Forest, H29 Black Spruce, Larch Forest.

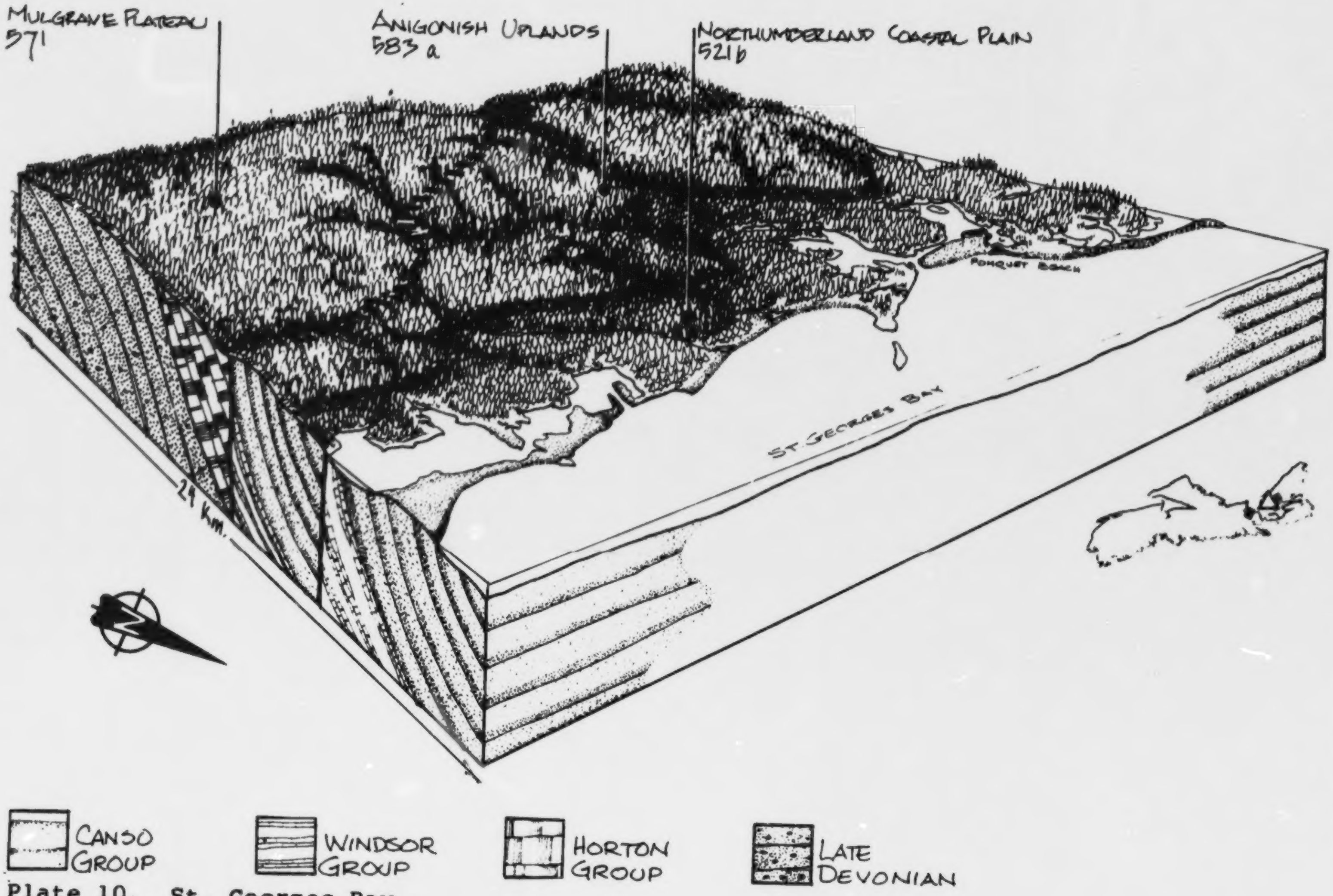

MULGRAVE PLATEAU
571
ANIGONISH UPLANDS
583 a
NORTHUMBERLAND COASTAL PLAIN
521 b
POMQUET BEACH
ST. GEORGES BAY
24 Km.
CANSO GROUP
WINDSOR GROUP
HORTON GROUP
LATE DEVONIAN

Plate 10. St. Georges Bay
Slabby sandstones of the Horton Group and Late Devonian age underlie the featureless upland called the Mulgrave Plateau (571). Drainage from this upland dissects the Antigonish Uplands (583) before entering the Coastal Plain (521) with its sandy barrier beaches and extensive coastal lagoons.

UNIT 522: JUDIQUE COASTAL LOWLAND

GEOLOGY AND GEOMORPHOLOGY

The Judique coastal lowland forms a very narrow band along the eastern side of St. Georges Bay and is the geological continuation of Unit 521b. It appears likely that the entire Bay area was once composed of the same strata as is now exposed around its rim. The Bay may have been carved out by an ancestral river flowing from the Scotian Shelf through the Strait of Canso.

At Port Hood a small area of grey Riversdale sandstone and shale contains thin coal seams. These dip under the waters of the Bay at an angle of 20°.

SOILS

The soils in the unit are predominantly imperfectly drained Queens clay loams, with its poorly drained associate the Kingsville series occurring frequently and over substantial acreages. Better drained soils of the Woodbourne and Shulie series are developed on tills derived from sandstone in small areas throughout the unit. Around Port Hood, Springhill soils occur. These sandy loams, related to Shulie soils, occupy imperfectly drained sites where water movement is restricted by the topography. Small areas of peat, coarse Hebert soils, Falmouth and Cumberland soils occur throughout.

VEGETATION

Louck's places this unit in the Sugar Maple, Hemlock, Pine Zone. The main influences on the vegetation are the wet, clay soils, the late spring and the effects of agricultural clearing. Softwoods are dominant. Many of the oldfields are regenerating in White Spruce (H.26) and Balsam Fir. Black Spruce and Larch (H.33) are found on the wetter areas. Tolerant hardwoods grow on some slopes, while a mixed forest (H.24) of spruce, and fir, with some intolerant hardwoods covers much of the area.

SITES OF SPECIAL INTEREST

Port Hood
- coal seams in Riversdale strata

Provincial Parks and Park Reserves
- Craigmore

UNIT 523: TANTRAMAR MARSHES

GEOLOGY AND GEOMORPHOLOGY

The Tantramar Marshes occupy a large area at the head of the Cumberland Basin where the flat terrain meets the sediment-loaded waters of the Bay of Fundy. The marshes are built up of fine silts and clays carried from the Bay by the spring tides.

The amount of sediment deposited by one tide depends upon the depth of water that covers the marsh and the rapidity with which it drains away. At Aulac Station between Amherst and Sackville it is estimated that 80 feet (25 m) of sediment have built up over a period of 3,000 to 5,000 years (the time scale was obtained from radiocarbon dates).

The marshes were built up very recently and quickly during a period of land subsidence and rising sea level. Increasing tidal ranges in the Bay of Fundy during the last 6,000 years have controlled their formation. The marshes have extended further inland during this period but have always been exposed to erosive forces at their outer edges. As the Bay of Fundy enlarges through erosion of the headlands the marshes are also enlarging, although retreating with the eroding coast at the same time.

As the marsh erodes remains of submerged forests and freshwater marshes are uncovered. Often the stumps and roots are washed away quickly once they have been uncovered, though more are revealed as new areas are exposed. Along the Missaguash River, however, stumps still remain after 150 years of exposure. At previous times the remains of spruce, beech, pine and Larch have all been seen.

Behind the marshes are extensive fresh water peat bogs. On the flat terrain freshwater is impeded from flowing into the Bay of Fundy by the extremely rapid deposition of silt on the salt marshes. As sea level has risen the salt marshes have built higher than the inland areas, forming a low dam behind which peat bogs have developed. Early settlers created farm land by cutting channels to the sea, through which the sediment rich waters of the Bay flowed to deposit silts above the peat.

SOILS

Three soil types dominate this Unit. At the coast and extending several miles inland are the reclaimed dyked soils known as Acadia. Freshwater is impounded inland of these marshland soils has formed extensive peat bogs. Adjacent mineral soils on flat, low-lying terrain are predominantly very poorly drained Masstown soils.

Acadia soils exhibit little horizon development due to continued deposition of marine sediments. These silty clay loams are either red-brown or grey with an abrupt boundary; the colour is thought to indicate a degree of gleying. When reclaimed and drained these soils are fertile, valuable agricultural soils.

As the peat is mainly formed on lowlying areas inland of the Acadia soils it is usually no more than 3 feet (1 m) thick. Former forests are often buried in the peat.

Masstown soils are poorly drained due to either depressional locations or the development of fragipans. A surface layer of organic material has developed up to 6 inches (15 cm) in depth. The underlying 'A' horizon is 10 inches (25 cm) thick. This sandy 'A' horizon can dry out very quickly when the water table drops, hence the soil tends to be either saturated or dry.

VEGETATION

Where dykelands have been maintained for agricultural use, they are covered by a variety of forage, grain and introduced plants. In the brackish and saline marsh areas the dominant species are Cord-grasses, (_Spartina alterniflora_, _S. patens_, and _S. pedinata_), with rushes, sedges, Common Reed (_Phragmites communis_), and a variety of other halophytes (for example _Suaeda_, _Salicornia_, _Triglochin_, _Plantago_, _Atriplex_, _Limonium_).

The low forested ridges mostly support Balsam Fir and White Spruce, with Red Maple and White Birch.

Extensive lake and bog areas contain a wide variety of aquatic plants, including pondweeds, Arrowhead, Cattails, Water-parsnip, and Bulrush.

FAUNA

This Unit is very important for both shorebirds and waterfowl. Thousands of shorebirds congregate in July and August to feed on the crustacean *Corophium* on the mud flats. In spring large numbers of Canada geese are concentrated in the salt marshes. Also visiting spring through fall are Black Duck, Green-winged Teal, Pintail, American Widgeon Blue-winged Teal and Ring-necked Duck. Freshwater impoundments created on the marshes by Ducks Unlimited have encouraged a number of new waterfowl and marsh bird species to nest in Nova Scotia including the following:

Ducks: Shoveler
Gadwall
Redhead
Ruddy
Marshbirds: Long-billed Marsh Wren
American Coot
Common Moorhen
Black Tern
Virginia Rail

Hawks and owls, hunting small mammals on the marshes, can be observed in fall and winter. The marshes also provide good habitat for raccoon, mink, fox, beaver and sometimes otter. Generally small mammal diversity is low (only three common species) but one of these; the Arctic Shrew, is very common. This shrew requires marsh or wet meadow habitat and is usually very local since continuous large expanses of that habitat are rare (the two largest are the Tantramar Marsh and the dykelands in the Grand Pré area).

The most common fishes in the ponds are the Threespine Stickleback, the Eastern Banded Killifish, and the Mummichog.

SITES OF SPECIAL INTEREST
Amherst Point Bird Sanctuary
John Lusby National Wildlife Area
(IBP Proposed Ecological Site 4)
- salt marsh.
Missaguash Marsh

ASSOCIATED TOPICS

T24 Modifying Forces, T25 Sea Level Change, T52 Shorebirds.

ASSOCIATED HABITATS

H6 Mud Flat, H7 Salt Marsh, H8 Coastal Fresh marsh, H15 Blanket and Raised Bog, H33 Black Spruce, Larch Forest.

530 Stoney and Wet Plain

GEOLOGY AND GEOMORPHOLOGY

District 530 is underlain by thick deposits of Late Carboniferous sandstone and siltstone which are either flat lying or gently folded. The strata contain numerous seams of coal which provide evidence of the environments of deposition.

During the Late Carboniferous the landscape in this area was low with little relief. Much of the area was covered with shallow lakes, bays, swamps and coastal floodplains. In some places (unit 532) there were rhythmic oscillations in the crust locally resulting in periodic subsidence which enabled thick layers of organic material to grow and then to be engulfed with sediments. In other places (unit 531) the crust was stable and the layers of organic material were separated by alluvial material deposited as the rivers meandered across floodplains.

The sandstones were deposited under continental conditions in lakes and contain few fossils of aquatic life. The coal seams and shales, on the other hand, provide imprints of leaves and delicate parts of plants. Fossil trees are also common and can usually be seen in coastal sections.

Overall the terrain varies from flat to rolling and is evenly covered with sandy to stoney glacial till. This till is thin and bedrock is frequently exposed at the crests of minor ridges. A complex landscape of bedrock sandstone ridges and poorly drained depressions with organic deposits characterizes these nearly flat landscapes.

District 530 is divided into two units:

531	Sydney Coalfield
532	Chignecto Plains

UNIT 531 SYDNEY COAL FIELD

GEOLOGY AND GEOMORPHOLOGY

The Sydney Coalfield lies within an area of Pictou-Morien Group sandstones and siltstones that cover an area of about 500 sq. miles (1,300 sq km). Within a thickness of 5,000 to 6,500 feet (1,500 to 2,000 m) of strata about 4,500 feet (1,300 m) contain coal seams. The strata have been relatively undisturbed and lie in open folds that dip gently seawards at angles of 4-15°.

The area is mantled with a sandy to stoney till and the coast offers the best geological exposures, although only a few layers can be seen at any one location. From Point Aconi to Port Morien, incuding the drowned estuary of Sydney River, there are exposures of sandstone including coal seams. One section northwest along the coast from Cranberry Point, which represents a 1,850 feet (560 m) vertical section, contains 34 coal seams and also fossil trees. A seam of coal 3 feet (1 m) thick is exposed in the cliff at Point Aconi and abundant plant fossils can be found in the shales on the beach. The shales are rich in leaves and other parts of plants, but some beds contain only one species, for example Spherophyllum in the dark shales at Point Aconi.

There are 12 productive seams in the Morien Group with the seams averaging 3-6 feet (1-2 m) in thickness. They are paralic in character, that is they tend to be extensive laterally and end abruptly against rock benches rather than merging into shales. The seams also tend to divide laterally. These characteristics reflect their origins on a river floodplain.

At present, mines extend 5 miles (8 km) from shore under the Cabot Strait, and within the present 6 mile (10 km) economically mineable limit there are 1,000 million tonnes of recoverable coal.

SOILS

The topography in this Unit is fairly level. On the gently undulating areas away from the coast well drained Shulie soils have developed on stoney sandy loam tills. Towards the coast where the terrain is flatter, imperfectly drained Springhill and poorly drained Economy soils have developed from the same material.

Extensive areas of peat bog are found in the depressions. Over much of the area the bedrock closely approaches the surface and can be readily observed as slabby sandstone outcrops along road cuts and shorelines. Around Boularderie Island imperfectly drained Diligence silt clay loams occur, with small areas of well drained Falmouth soils formed over gypsum, (see unit 511) and some Hebert soils on outwash sands and gravels.

VEGETATION

This Unit has a somewhat milder climate than much of the Carboniferous Lowlands, although cold strong winds from the north-east retard spring time warming. A second major factor has been the high degree of disturbance. The Unit lies within Louck's Sugar Maple - hemlock - pine zone, but repeated disturbance has resulted in a forest dominated by conifers - White Spruce, Black Spruce, Balsam Fir and Larch (H.32 and H.33). Poor quality intolerant hardwoods occur on ridges in the coniferous forests, while the maple-aspen and birch (H.22) fire association is found on extensive burnt areas.

There are a few salt marsh areas with Eel Grass beds in the vicinity of Glace Bay and Port Morien. Scouring by sea ice in winter limits the growth of marine algae.

FAUNA

A large proportion of this Unit is taken up by urban land uses. Elsewhere mostly scrub or early successional forest habitats are provided. Some Bald Eagle nesting habitat occurs. The main faunistic interest is focussed on the coast which includes vertical cliffs which provide sea bird nesting sites, and sheltered bays cut off from the open sea by barrier beaches. There are few islands but two of them, Ciboux and Hertford (Bird Islands), are nationally important nesting areas for Razorbill, Common Puffin, Leach's Storm Petrel and Kittiwakes. Big Glace Bay Lake and Morien Bay provide stop-over areas for modest numbers of migratory waterfowl, but are of particular interest because a wide variety of species are included. The Piping Plover nests at the Glace Bay Sanctuary. Cormorant breeding colonies occur along the coast.

SITES OF SPECIAL INTEREST

Coastline northeast of Cranberry Head
- 34 coal seams and fossil trees

Point Aconi
- plant imprints and fossils in the shales along the beach.

Bird Islands (IBP Proposed Ecological Site 24)
- bird nesting site, with rare arctic - alpine plants. One is owned by the N.S. Bird Society, the other by the Department of Lands and Forests..

Big Glace Bay Lake Migratory Bird Sanctuary

Provincial Parks and Park Reserves
- Groves Point
- Big Bras d'Or
- Dalem Lake
- Mira River
- Dominion Beach
- Lingan

ASSOCIATED TOPICS

T16 Colonization by Plants, T23 Oceanic Environments, T26 Coastal Landforms, T34 Biological Environment, T52 Shorebirds, T53 Seabirds.

ASSOCIATED HABITATS

H19 Cliff , H22 Maple, Oak Birch Forest, H32 Spruce, Fir-Maple, Birch (Coastal) Forest.

UNIT 532: CHIGNECTO PLAINS

GEOLOGY AND GEOMORPHOLOGY

Most of the area is underlain by Cumberland Group strata made up of grey sandstones and shales. In places the sandstone is coarse and in others it is even-grained and has been used for millstones and building stone. The strata have been thrown into open folds which become tighter close to the Cobequids (581). Some of the anticlines in the east of Unit 532 have been eroded exposing the underlying Windsor Group deposits. In these places the folding is accentuated by the movement of salt which rises through the strata forming domes.

Glacial deposits mask most of the Chignecto Plains and the strata can best be seen along the shore of Chignecto Bay. The most important section lies in the 9 miles (15 km) between Minudie and Shulie, where a vertical section of 14,800 feet (4,444 m) of Cumberland Group strata is exposed. These strata form part of a shallow basin that extends from Minudie to the Cobequids. Towards Shulie they dip northwards and from Shulie to the Cobequids they dip southwards.

From the Joggins area to Maccan and Springhill the luxuriant growth of Lepidodendron, Calamites, Chordaites, tree ferns and seed ferns resulted in the formation of many coal seams. Up to 70 seams have been found in this basin with the thickest ones near Joggins (from Joggins to Ragged Reef). The main seam at Joggins is 4 feet (1.25 m) thick.

The seams can be traced inland for 18 miles (30 km) but gradually decrease in number. Four outcrop at River Hebert, two each at Maccan and Chignecto. At Springhill the section of coal-bearing strata is 2,654 feet (800 m) thick and contains 31 coal layers.

The coal seams in the Cumberland Basin formed in an unstable environment characterized by subsidence, plant growth, inundation and burial by mud and sand, more growth, and so on in a cyclic progression. The coal seams tend to grade into shaly coal and coaly shale vertically and laterally. They are structurally weak and dangerous to work at depth.

In a well-known locality near Joggins there is a classic coastal section of Late Carboniferous strata. Between Coal Mine Point and Lower Cove tree stumps of Calamites and Sigillaria can be seen in their original growth positions. Siltstones rich in plant debris and limestones containing the shells of freshwater and brackish water pelecypods and ostracods occur. Amphibian and reptile bones and the tracks of giant arthropods have also been found. Sedimentary structures in the strata include ripple marks, wave ripples, current bedding, mud cracks, rain prints and channel deposits.

Outcrops of sandstone bedrock create a bedrock dominated landscape west of the River Hebert. To the east of the river extensive sandy tills mask the bedrock.

SOILS

Gray and brown sandstones and reddish brown conglomerates have provided the parent materials for the dominant soils of this unit. Shulie, Springhill (imperfectly drained) and Economy (poorly drained) soils have developed from sandstones. For the most part they are relatively shallow, stoney loams. West of the River Hebert there are large areas of very shallow soils.... The haphazard interference of bedrock with soil drainage creates an intricate pattern of imperfectly and poorly drained depressions.

VEGETATION

This Unit falls within the Maritimes Lowland Ecoregion of Louck's Red Spruce-Hemlock-Pine zone, and has been heavily disturbed by repeated cutting and burning and by scattered agricultural settlements. Sandy areas have a coniferous forest dominated by Jack Pine, Red and Black Spruce. Scattered pure stands of Yellow Birch occur on side slopes and ridges near Chignecto Bay. Jack Pine, aspen, spruces and Grey Birch are abundant after fire. Heathland has formed on some of the old burns others are reverting to Red and Black Spruce and Balsam Fir. The so-called Chignecto Barrens are now regenerating in Red and Black Spruce, some have been planted with Red Pine. Well drained hills are covered with intolerant hardwoods and some tolerant hardwoods. Some cedar is found in this unit and the adjacent areas. The only other area in Nova Scotia with cedar is Digby County.

In 1912 C.D. Howe made the following observations on soil-forest relationships in this fire devasted area: "The sandy plain is covered with small sandy knolls from one to two feet above the little depressions which are from a yard to five yards in diameter. The bedrock is a hard, fine-grained sandstone which, in general, is apparently not more than two feet below the surface. The vegetation is composed of wire birch and scattering jack pine, which escaped the fire, with an undergrowth of blueberry, sheep laurel and hair cap moss. The damp pockets contain purple laurel (rhodora), Labrador tea and sometimes spruce seedlings. Jack pine seedlings are frequent on the knolls."

FAUNA

This Unit provides a mix of hardwood and softwood forest habitats, with small agricultural areas. Along the coast, cliffs - lower towards the head of the bay and higher towards Apple River - and intertidal sands and muds occur. The area offers prime moose and deer habitat, and good bear habitat. Raccoons are found near the scattered agricultural settlements. Beaver densities are low. The Maccan marshes provide significant waterfowl breeding areas, and are part of the important Cumberland Basin area, see description of adjacent unit, Tantramar Marshes (533). There are very few lakes. Freshwater fauna is somewhat more diverse, and the Blacknosed Dace is possibly common.

SITES OF SPECIAL INTEREST

Joggins (Coal Mine Point to Lower Cove)
- fossil trees, reptile remains, sedimentary structure. A classic Late Carboniferous section.
- coal seams outcropping along the shoreline of Chignecto Bay.
- two district tills, different in colour, containing boulders of granite and limestone.

Chignecto Game Reserve
Shulie River (IBP Proposed Ecological Site 2)
- Red Spruce stand

Chignecto River (IBP Proposed Ecological Site 3)
- pure stand of Red Pine

ASSOCIATED TOPICS

T26 Coastal Landforms, T42 Trees.

ASSOCIATED HABITATS

H6 Mudflat , H17 Barren, H19 Cliff .

540 Clay Plain

GEOLOGY AND GEOMORPHOLOGY	In two areas within the Till Plain (district 510) there are Middle to Late Carboniferous deposits of Canso and Pictou strata. They are predominantly fine red or grey/brown sandstones and siltstones, known as the Scotch Village Formation, which lie horizontally on top of the Windsor deposits. These two areas are 540a Cogmagun Barrens and 540b Stewiacke Barrens.
SOILS	The soils in this unit are mainly of the Kingsville series - poorly drained clay loams usually strongly mottled. These have formed from till deposits derived from gray sand and siltstones. Large areas of peat have developed on the level to depressional topography.
VEGETATION	This clay till plain with scattered mounds supports mostly Black Spruce, with some Red Oak and Balsam Fir. On the better drained gravelly ridges Red Pine (on burnt sites), and the intolerant hardwoods Red Maple and White Birch occur. There are also many large bogs.

ASSOCIATED HABITATS

H14 Blanket and Raised Bog .

550 Coastal Fringe

GEOLOGY AND GEOMORPHOLOGY

Around the shoreline of the northern Cape Breton peninsula is a narrow fringe of Carboniferous strata. This forms a usually flat area at the base of the steep dissected shoulder of coarse Horton deposits and volcanics which flank the Highland massif.

The widest parts of this band of lowland are found between Margaree Harbour and Cheticamp and in the Aspy Valley. Around St. Ann's Bay to Cape Smokey the band is very narrow with only vestiges remaining of the original deposits. Much of the strata are composed of Windsor Group deposits which are being eroded very rapidly. Where gypsum underlies the surface, karst topography has formed.

On the west side of the peninsula from Margaree Harbour to Cheticamp the Windsor deposits are overlain by a narrow strip of younger rocks, Riversdale strata (including some coal seams) and, further north near Cheticamp, red Canso strata. All around the coastline the pre-Wisconsin wave-cut notch can be seen overlain by loose glacial material. Glacial sands and gravels washed down from the highlands are common throughout the District.

District 550 is divided into two Units; primarily on the basis of oceanographic and climatic conditions:

551 Inverness Coastal Plain
552 Victoria Coastal Plain

UNIT 551: INVERNESS COASTAL PLAIN

The Inverness Coastal Plain is divided geographically into two areas:
551a) Inverness/St. Rose Coalfield
551b) Cheticamp Coast

GEOLOGY AND GEOMORPHOLOGY

551a) Inverness/St. Rose Coalfield
From Inverness northwards towards Margaree Harbour lies a hilly, faulted narrow belt of Late Carboniferous strata. They form two small basins, one centred at Inverness and the other at Chimney Corner. Both basins contain coal seams. At Inverness they are in Pictou strata and at Chimney corner in Riversdale strata. In both areas the coal has been mined but the seams dip steeply out under the Northumberland Strait so that much of the coal is inaccessible.

551b) Cheticamp Coast
Beyond Margaree Harbour a thin strip of Windsor strata overlain by red Canso Group sandstones and siltstones and greyish Riversdale sandstones form a narrow coastal plain. The Windsor strata form a valley at the base of the highland slope and, where gypsum occurs, karst topography occurs. Sinkholes and small lakes are common. Near Cheticamp where the plain broadens, extensive gypsum deposits have been mined down to the underlying anhydrite. Crystalline gypsum (selenite) is common.

Cheticamp Island is composed of the red Riversdale sandstones and is undergoing rapid erosion. At present it is connected to the mainland by a long sand and gravel bar. Just to the north coastal erosion has reduced a deposit of red Carboniferous sandstone to stacks which lie at the mouth of Trout Brook. The sandstone generally forms low cliffs along the shore.

North of Cheticamp Village is a terrace of glacial outwash material. A bar has formed across the mouth of the Cheticamp River and an esker projects out to the bar dividing the lagoon into two.

SOILS

The soils in this unit form a complex mix, ranging from sands to clay loams. The dominant soil is Shulie, which has developed from glacial tills derived from coarse gray and brown sandstones of the Riversdale group. They range from stoney loam to stoney sandy loam in texture.

551a - Inverness St. Rose Coalfield

The outlet of Lake Ainslie is marked by a large sand plug with outwash sands and gravels, on which well drained Canning loamy sands have developed. These soils are on level to rolling terrain and tend to be droughty. Elsewhere imperfectly drained Queens and poorly drained Kingsville clay loams have developed. Well drained Shulie soils occur on higher ground north of Broad Cove.

551b - Cheticamp Coast

Small areas of sandy Canning soils occur around Margaree Harbour. Further north along the coast Queens, Kingsville and Shulie soils occur with some well drained Pugwash sandy loam and its poorly drained associate Masstown. Digby soils (excessively drained sandy loams) have developed on beach deposits. Near Cheticamp, Hebert soils are found on outwash sands and gravels. Cheticamp Island is a mix of Shulie, Debert, Masstown and Kingsville soils.

VEGETATION

The vegetation in this unit is very much influenced by the prevailing westerly winds off the Gulf of St. Lawrence. White Spruce is the most common species, but tolerant hardwoods are found on the better drained and more sheltered sites. Black Spruce and Larch grow in wet, depressional areas. Elsewhere a mixed forest of spruce, fir and pine with maple and birch (H.32) is widespread. Marsh Marigold is scattered along the lowland in wet places.

FAUNA

Margaree Island provides some breeding habitat for sea birds, including a moderate population of Black Guillemot.

SITES OF SPECIAL INTEREST

Petit-Etang (IBP Proposed Ecological Site 16)
- circumneutral eutrophic marsh with uncommon plants.

Chimney Corner, Cheticamp, Cape North, St. Ann's Bay
- a pre-glacial wave-cut notch can be seen in the side of the cliffs.

Cheticamp
- selenite in an old gypsum quarry; karst topography,

Chimney Corner, Inverness
- thin coal seams in the sandstone and siltstone along the shore,

Trout Brook (north of Cheticamp)
- stacks of red sandstone

Provincial Parks and Park Reserves
- Broad Cove Marsh
- Friar's Head
- St. Joseph du Moine

ASSOCIATED TOPICS

T21 Ocean Currents, T25 Sea Level Change, T53 Seabirds.

ASSOCIATED HABITATS

H32 White Spruce, Fir-Maple, Birch (Coastal) Forest.

UNIT 552: VICTORIA COASTAL PLAIN

The Victoria Coastal Plain is divided geographically into three areas:
a) Aspy River
b) Ingonish River
c) St. Ann's Bay

552a) Aspy River

GEOLOGY AND GEOMORPHOLOGY

The Aspy Valley lies south of the escarpment of the Aspy Fault. From the bars across the harbour south to Sunrise the valley is underlain by Windsor strata which form a broad level lowland. Where gypsum underlies the surface karst topography with sinkholes has formed. Gypsum has been mined at Dingwall.

South of Sunrise the Aspy Valley contains Horton strata which form hills below the escarpment.

552b) Ingonish River

At Ingonish Windsor strata lie directly on top of basement rocks with no Horton strata present. They form a narrow lowland on the north side of Ingonish Bay.

552c) St. Ann's Bay

The coastal margin from Cape Smokey to Indian Brook consists of a narrow band of Windsor and related strata. On the west side of St. Ann's Bay are resistant Horton strata. At the southern end of St. Ann's Harbour a strip of Windsor lies between the plateau to the west and the parallel upland block to the east known as Kelly's Mountain.

The extent of coastal erosion is indicated by the location of the Carboniferous deposits which once covered a much wider area on the coastline.

SOILS

This unit is notable for its outwash deposits on which gravelly sandy loams of the Hebert series have developed. On the upland slopes in this unit the soils have derived principally from granite and are mapped as well-drained Gibraltar and imperfectly drained Bayswater sandy loams. Along St. Ann's Bay (552c) Thom soils are also found on the slopes. The Aspy River has cut terraces in alluvial deposits. These successive terraces present an ideal opportunity for measuring the time and intensity of soil development processes.

VEGETATION

On the floodplains willow, aspen, Sugar Maple and Yellow Birch are found. On better drained gravels white birch and beech occur. On the granitic slopes White Spruce is common with scattered Yellow Birch and Sugar Maple.

Along the coast winter ice scour restricts marine algae.

FAUNA

Scattered eagle breeding habitat occurs in this Unit. A moderate sized heron colony exists in Aspy Bay, which is also visited by a wide variety of waterfowl from spring through fall, though not in large numbers. Barachois ponds occur behind barrier beaches, and support a diverse aquatic fauna.

SITES OF SPECIAL INTEREST

Dingwall
- gypsum and karst topography,

Provincial Parks and Park Reserves
- Cabot's Landing
- Ingonish
- Birch Plain
- Breton Cove
- Plaster

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T23 Oceanographic Environments, T26 Coastal Landforms, T36 Algae

ASSOCIATED HABITATS

H3 Rocky Shore, H4 Boulder, Cobble Shore, H19 Cliff

560 Submerged Lowland

GEOLOGY AND GEOMORPHOLOGY

The Submerged (Bras d'Or) Lowlands form a fringe around the upland areas of central and eastern Cape Breton. The Lowlands are underlain by Windsor Group strata containing siltstone, shale, reddish sandstone, limestone, gypsum, anhydrite and salt, which once ranged in thickness from 2,000 to 4,000 feet (650 to 1,200 m). They were laid down often in cyclical deposition patterns under a variety of conditions; in shallow offshore environments; in restricted basins where there was greater evaporation; and in open basins. The depositional basins lay around and between the upland blocks of the Creignish Hills, North Mountain, Sporting Mountain, East Bay Hills and the Boisdale Hills.

During the Tertiary period a dramatic drop in sea level, probably caused by crustal uplift after the formation of the Cretaceous planation surface, allowed deep erosion to take place. At that time major features such as the Gulf of St. Lawrence were carved out, and in central Cape Breton the lowlands were eroded to well below present sea level. When the land subsided the sea was able to enter through two channels, the Great Bras d'Or and Lennox Passage, forming a deep lake 600 feet (180 m) deep in a few places, with access to the sea.

Now the Windsor strata form an eroding broken fringe at sea level around the base of the uplands. The landscape consists of steep slopes with some cliffs, dropping to a coastal plain where there are white gypsum deposits and red sedimentary strata. The uplands, lowlands and channels are oriented in a northeast-southwest direction in accordance with the structural trend in Cape Breton.

SOILS

Shales and mudstones have produced most of the soils in this area. Gypsum occurrences are very frequent and produce improved drainage in soils immediately above them. Falmouth (well drained), Queens (imperfectly drained) and Kingsville (poorly drained) soils are predominant. These are loams and clay loams derived from clay loam tills. Areas of coarser-textured Thom and Westbrook soils also occur. Millar soils have developed on outwash deposits. Although these are coarse-textured sandy loams, they are poorly drained because of the depressional topography.

VEGETATION

This Unit is part of Louck's Sugar Maple-Hemlock-Pine zone, but the heavy soils and repeated disturbance have resulted in a largely softwood forest, with White Spruce, Balsam Fir, and scattered Hemlock. Tolerant hardwoods are found on some of the better drained slopes. The intolerand hardwoods, Red Maple and White Birch occur in mixed stands. Oldfields and former pasture have regenerated in pure stands of White Spruce or in spruce and fir. Black Spruce and Larch grow in the wetter areas.

FAUNA

The Submerged (Bras d'Or) Lowlands district includes a mix of flat or rolling softwood or mixedwood forest habitats, oldfields, open brackish water, sheltered marshy inlets and exposed rocky shoreline. The Bras d'Or Lake supports a distinct warm water marine community, which is impoverished compared with other estuaries or coastal waters in Nova Scotia. Polychaete/bivalve communities are found in the mud and gravel bottom. The unit provides very important Bald Eagle nesting habitat, particularly in the vicinity of Boom Island. Great Blue Heron and Double-crested Cormorant colonies are also present. River Denys and the Upper Denys Basin are important areas for waterfowl production and act as a staging area for migrating Teal, Black Duck, and Ring-necked Duck. It is also known as a wintering area for Bald Eagles. The estuaries and streams provide good muskrat and mink habitat. Snowshoe Hare and bobcat also use habitats in this Unit.

SITES OF SPECIAL INTEREST

Provincial Parks and Park Reserves
- Big Harbour Beach
- Ross Ferry
- Baddeck Inlet
- Orangedale
- Battery
- Hay Cove
- Irish Cove
- Castle Bay
- Blacketts Lake
- Dundee

ASSOCIATED TOPICS

T22 Tides, T51 Birds of Prey, T63 Marine Invertebrates.

ASSOCIATED HABITATS

H1 Benthic, H2 Open Water.

570 Rolling Upland

GEOLOGY AND GEOMORPHOLOGY

From the Strait of Canso across the southern side of the Pictou-Antigonish Highlands to the southern border of the Cobequid Hills, Devonian and Carboniferous strata form a rather featureless central axis to Nova Scotia. South and west of the Salmon River in Guysborough County the boundaries of this block are the major faults which cross the province from east to west. To the north is the Chedabucto Fault which extends from Cooks Cove across southern Pictou County, merging with the Cobequid Fault along the southern border of the Cobequid Hills. To the south, the St. Marys Fault extends from eastern Guysborough County across to the Stewiacke Valley. The southern district boundary continues along the Cobequids as the Portapique Fault. The area from Salmon River northward to the Strait of Canso is the extension of this band of rocks on the northern side of the escarpment of the Chedabucto Fault.

District 570 is divided geologically and topographically into two units:
- 571 Mulgrave Plateau
- 572 St. Mary's Fault Block

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia.

UNIT 571: MULGRAVE PLATEAU

GEOLOGY AND GEOMORPHOLOGY

The Mulgrave Plateau lies within the Avalon Zone of Nova Scotia. The Avalon basement strata are overlain by resistant, Middle and Late Devonian rocks including coarse sandstones and conglomerates with basalts and other volcanic deposits including a dyke. These strata were deposited at about the time of the Acadian Orogeny when the Avalon and Meguma zone rocks joined together, and it is reasonable to expect that they would reflect these crustal disturbances.

The elevation on the Mulgrave Plateau reaches over 650 feet (200 m) on the west side, falling to below 450 feet (130 m) near the Strait of Canso. At Cape Argos and Chedabucto Bay it is about 150 feet (50 m). The scarp along the Chedabucto Fault separates these Devonian rocks from younger Horton strata and is an important physiographic feature.

Apart from this regional slope to the east, there is little variation in relief on the plateau. The upland surface is uniformly covered in a stony till and there are few features of interest. One rather beautiful area lies along the Roman Valley where the river has exploited a fault line producing a steep sided valley which cuts into the plateau. The river flows in a large drowned estuary to Milford Haven and Guysborough.

SOILS

Soils in this Unit have derived mainly from shales and tend to be heavy and comparatively shallow. Millbrook clay loams occur north of Chedabucto Bay. Elsewhere the soils are mainly Riverport and Kirkhill shaly loams, with some blocks of Thom sandy loams, associated with upland areas.

VEGETATION

This unit includes a wide variety of forest associations. On the deeper soils west of Mulgrave mixedwoods predominate with Balsam Fir, Black Spruce, Hemlock, Sugar Maple and beech. On the wetter sites Black Spruce, Balsam Fir and Larch occur, with more White Spruce, Yellow Birch and aspen appearing on better drained sites. On shallow soils such as those around Lincolnville fir, Black Spruce and White Spruce grow with Larch, intolerant hardwoods and aspen.

West of Middle Melford, where the clay soils have been water-worked, the better drainage encourages a mixed forest. The changing nature of the forest can be guaged from the following observations on soil-forest relationships made by C.D. Howe in 1912. "The forestal nature of the (western) portion may be characterized very briefly: barrens and semi-barrens interspersed with bogs and low hardwood ridges. The forest on the broad belt of lake Lochaber is of the mixed type with hardwoods, chiefly yellow birch, forming one-half of the stand, the rest being red spruce and fir in about equal proportions. The crests of the hills and ridges are pure hardwood, 90 percent of which is often yellow birch, the remaining being beech, hard maple (Sugar Maple) and paper birch. East of the Cross Lake region to the Guysborough river, practically pure hardwoods prevail. As one approaches the coast from the interior, fir and spruce form a large proportion of the forest." This is the coastal forest (region 800).

SITES OF SPECIAL INTEREST

Goshen
- view southwards across the St. Marys Fault Block to the escarpment of the St. Marys Fault.

Roman Valley
- steep sided, v-shaped valley leading to a wide estuary near Milford Haven.

Provincial Parks and Park Reserves
- Lochaber
- Giant's Lake
- Port Shoreham
- Wharf
- Guysborough Railway (part)

ASSOCIATED TOPICS

T4 The Avalon and Meguma Zones.

UNIT 572: ST. MARYS FAULT BLOCK

GEOLOGY AND GEOMORPHOLOGY

South of the Chedabucto-Cobequid Fault is a band of Horton rocks lying in a graben; (a downfaulted block lying between two parallel faults). Across central Nova Scotia it is about 9 miles (15 km) wide and has as escarpment on the south that becomes increasingly prominent from the Eden Lake-Caledonia line eastwards.

Within the graben the elevations decrease gradually to the south and west. In Pictou County the elevation is 750 to 800 feet (225 to 240 m) falling to 575 feet (175 m) at the Southern Uplands and 400 feet (120 m) near Melrose. From Trafalgar westwards the drainage is all towards the St. Marys River confluence at Melrose. The East St. Marys River drains along the Chedabucto Fault in southern Pictou County, eroding crushed material from the fault zone before heading southwards to Melrose. The West St. Marys River has extended its headwaters along the line of the St. Marys Fault and has captured all the drainage flowing south across the graben in that area. Erosion by the river has exposed the fault scarp which becomes increasingly prominent towards Melrose. The drainage pattern in the watershed of the West St. Marys River and its tributaries is rectangular. The north-south and east-west directions probably reflect the joint pattern in the coarse Horton sandstones.

The western half of the St. Marys Fault Block is a uniform upland which runs along the southern side of the Cobequid Hills between the Cobequid Fault and the Portapique Fault. The Cobequid Fault forms the dividing line between the Avalon basement rocks of the Cobequid fault block to the north and the Carboniferous strata (Pictou and Riversdale) to the south. The Portapique Fault sets the Carboniferous rocks against the Triassic deposits which surround Cobequid Bay.

Along the southern margin of the Cobequids the relief becomes hilly as the fault slices narrow and are crosscut by fast flowing streams draining into Cobequid Bay.

SOILS

The tills derived from the hard gray sandstones of the Horton Group are midway between those derived from Halifax quartzites and those from the softer Shulie sandstones. Consequently soils usually associated with both these bedrocks are found in this Unit. Halifax soils (well drained sandy loam) occurs with small areas of Aspotogan soil and peat. Shulie soils (gravelly silt loams to sandy loams) are more prevalent, with Springhill sandy loams and Millbrook gravelly clay loams. The western extension of this unit south of the Cobequids has a complex mix of soils of all textures from gravels to clays.

VEGETATION

The relatively flat, ill-drained topography and the extensive cutting in this Unit have favoured softwoods; Balsam Fir, White Spruce, White Pine, Red Spruce and Hemlock. Scattered Red Oak is found throughout. Tolerant hardwoods with some intolerant hardwoods occur on some better drained sites. The more gently undulating areas with shallow soils are dominated by spruce and fir. Extensive barren lands, apparently originating with repeated burning, are dominated by Sheep Laurel and Bracken with scattered pine, maple and Black Spruce. A recent extensive burn near Trafalgar is now being replanted. C.D. Howe made the following observations on soil-forest relationships in 1912. "South of the railway to the height-of-land ... the country is made up of low rounded ridges and depressions. The higher points are covered with hardwoods, while the bases of the slopes and the forested depressions support mixed stands in which the conifers are in the majority. As a whole, one-half of the forested areas is composed of red spruce, fir and hemlock."

Two small floodplains in this Unit, one at Kemptown and one at Glencoe, are of particular botanical interest because they support a rich and rare intervale flora.

SITES OF SPECIAL INTEREST	Kemptown intervale (IBP Proposed Ecological Site 9) - intervale flora Glencoe intervale (IBP Proposed Ecological Site 10) - intervale flora Provincial Parks and Park Reserves - Two Mile Lake - Guysborough Railway (part) Economy River (IBP Proposed Ecological Site 8) - Old Growth Red Spruce Forest.

ASSOCIATED HABITATS

H12 Slow-moving Stream, H13 Fast-moving Stream, H17 Barren, H34 Sugar Maple, Elm (Flood Plain) Forest.

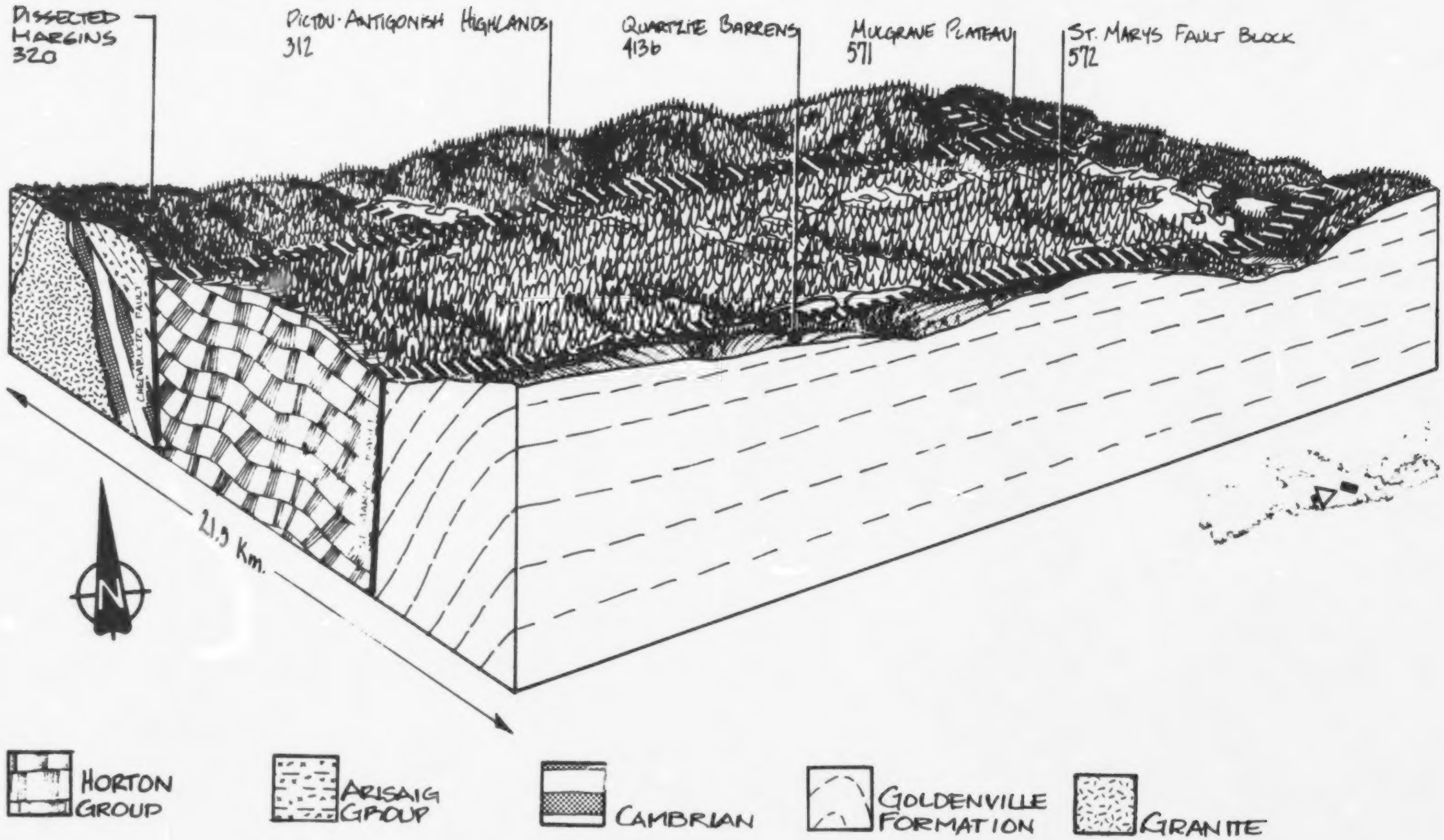

DISSECTED MARGINS 320
PICTOU·ANTIGONISH HIGHLANDS 312
QUARTZITE BARRENS 413b
MULGRAVE PLATEAU 571
ST. MARYS FAULT BLOCK 572
CHEDABUCTO FAULT
ST. MARYS FAULT
21.9 Km.
N
HORTON GROUP
ARISAIG GROUP
CAMBRIAN
GOLDENVILLE FORMATION
GRANITE

Plate 11. St. Mary's River
A massive downfaulted block (graben) of Horton sandstone (572) is bounded on the south by Goldenville Formation quartzite (413) and to the north by Avalon zone rocks of the Pictou-Antigonish Highlands (312) and its Dissected Margins (320). These more resistant rocks both form prominent dissected scarp slopes. The St. Mary's Fault has been excavated by the St. Marys River while the Chedabucto Fault is followed by the East River of Pictou.

580 Hills and Valleys

GEOLOGY AND GEOMORPHOLOGY

This District includes two areas of Carboniferous strata that both have the characteristics of foothills. They are adjacent to faulted upland blocks which have moved vertically upwards in the landscape. The close interrelationship of resistant Horton Group Strata and the overlying, less resistant Windsor Group limestone, salts and shales is strongly reflected in the eastern sections of this district (Units 583, 584 and 585). The units within this District are:

581	Cumberland Hills
582	Pictou Valleys
583	Antigonish Uplands
584	Ainslie Uplands
585	Iona Uplands

Some areas are lowland, others are upland, reflecting both the position of these strata on the tilted planation surface and the relative proportions of Horton and Windsor deposits. Except in the Pictou Valleys unit these strata have been compressed into folds which lie parallel to the axis of the province. Typically erosion has removed Horton strata in the centre of anticlines (upfolds) and left the Windsor strata in the synclinal hollows in between. In some locations Windsor strata have also been protected from erosion by downfaulting as in the Pictou Valleys. Where resistant Horton grits are exposed they stand as ridges and as shoulders on the flanks of highland blocks. The Windsor deposits form low areas and valleys, in which salt springs and brackish lakes are common.

UNIT 581: CUMBERLAND HILLS

GEOLOGY AND GEOMORPHOLOGY

North of the Cobequid Hills, between Wentworth and West Apple River, lies a hilly, dissected terrain underlain by Cumberland Group sandstones and conglomerates. The strata dip northwards away from the Cobequid Hills and proceed through folds of increasing wavelength down to the Northumberland Plain (unit 521).

There is some evidence that following the retreat of the ice across the Cobequids at the end of the ice age, permafrost conditions may have existed since associated soil structures are found in this area.

SOILS

Soils in this unit are either relatively coarse textured, well drained, and derived from sandstones and conglomerates, or finer textured clay loams developed from shale and mudstone derived materials. In the former category are the gravelly sandy loams of the Rodney and Westbrook series. In the latter category are Queens, Kingsville, Joggins and Diligence. In the river valleys Hebert soils have developed on outwash deposits. Throughout the unit small areas of Economy soils, which are strongly acid and saturated for much of the year, occur on poorly drained or gently sloping sites. Commenting on the slow recovery of forests after fire on the conglomerate areas, C.D. Howe wrote in 1912: "To the westward the conglomerate belt has been severely burnt. From the effects of burning the conglomerate recovers nearly as slowly as does the quartzite. On the conglomerate at the headwaters of Apple river, there is a fairly good forest in which spruce prevails, although interrupted by frequent barrens and bogs."

VEGETATION

Softwoods and mixedwoods predominate, with Red Spruce, Balsam Fir, Red Maple and birch being abundant. Sugar Maple, Beech and Yellow Birch are found on better drained upper slopes.

On the well drained upper slopes of the high rolling hills Sugar Maple, Yellow Birch and beech are common, and many Sugar Maple camps have been established. The bulk of Nova Scotia's maple sugar is produced in this unit. Small abandoned farms are found in this area, and some of the land is now being used to grow blueberries. White Pine and Jack Pine are common on old burns.

SITES OF SPECIAL INTEREST	Fenwick (IBP Proposed Ecological Site 5) - deciduous forest, primarily Sugar Maple, with a Sugar Maple camp. Provincial Parks and Park Reserves - Fenwick

ASSOCIATED HABITATS

H13 Rapidly-moving Stream, H14 Blanket and Raised Bog, H17 Barren, H27 Sugar Maple, Yellow Birch, Beech Forest, H29 Pine Forest.

UNIT 582: PICTOU VALLEYS

GEOLOGY AND GEOMORPHOLOGY

This hilly area between the Cobequid Hills and the Pictou-Antigonish Highlands is underlain by Late Carboniferous Canso and Pictou strata which are interrupted on the southeastern margin by triangular up-faulted blocks of Windsor strata. A separate part of this Unit lies east of central Pictou between McArras Brook and Doctors Brook. It is shown on the map as 582(b).

The Windsor Group strata are predominantly composed of sandstone and siltstone with minor amounts of gypsum and anhydrite. The landscape reflects the dominance of these relatively more resistant rocks and although it is well dissected by streams elevations do exceed 650 feet (200 m) in places and reach 750 feet (225 m) at Hopewell and Lorne.

Part of the East River north of Sunnybrae is a fossil valley that became filled with Windsor deposits and is now being re-exposed. In the central part of the Pictou Valleys Unit is the Pictou coalfield. The basin in which the coalfield sits developed as a physiographic feature during the Acadian Orogeny when it was downfaulted. Since then it has acted as a sedimentary sink, and during the Late Carboniferous provided a suitable environment for the development of coal seams.

The coalfield underlies an area of about 3 miles (5 km) by 10 miles (16 km) beneath New Glasgow, Stellarton and Trenton. The coal seams lie in grey shales which are open folds, dipping to the east. The total thickness of the coalfield is about 8,500 feet (2,600 m) and bears up to 45 seams, 11 of which have been mined. The three main coal producing districts are Thorburn, Albion and Westville.

The coal seams were formed in a tectonically unstable area in which periods of quiet plant growth were separated by subsidence and inundation by muds. The seams therefore grade vertically and laterally into shaly coal and coaly shale.

SOILS

The soils in this unit have been derived from shales and sandstones.

(582a - Pictou Rivers)
Well drained Woodbourne soils (gravelly clay loams) are found associated with imperfectly drained Millbrook clay loams, with small amounts of gravelly Hebert soils formed on glaciofluvial deposits. Clay soils of the Queens and Joggins series are found around Stellarton.

(582b - McArras Brook)
Woodbourne soils also occur here together with Barney soils south of Arisaig (well drained shaly loams).

VEGETATION	Soils in this unit are productive and much of the area is farmed. White Spruce and Balsam Fir grow on old fields and pastures. Sugar Maple, Yellow Birch, Beech (H.27) grow on slopes, with some intolerant hardwoods and aspen.
SITES OF SPECIAL INTEREST	Fossils at Arisaig Provincial Parks and Park Reserves - Salt Springs - Greenhill - Guysborough Railway (part) - Arisaig

ASSOCIATED HABITATS

H18 Oldfield , H27 Sugar Maple, Yellow Birch, Beech Forest.

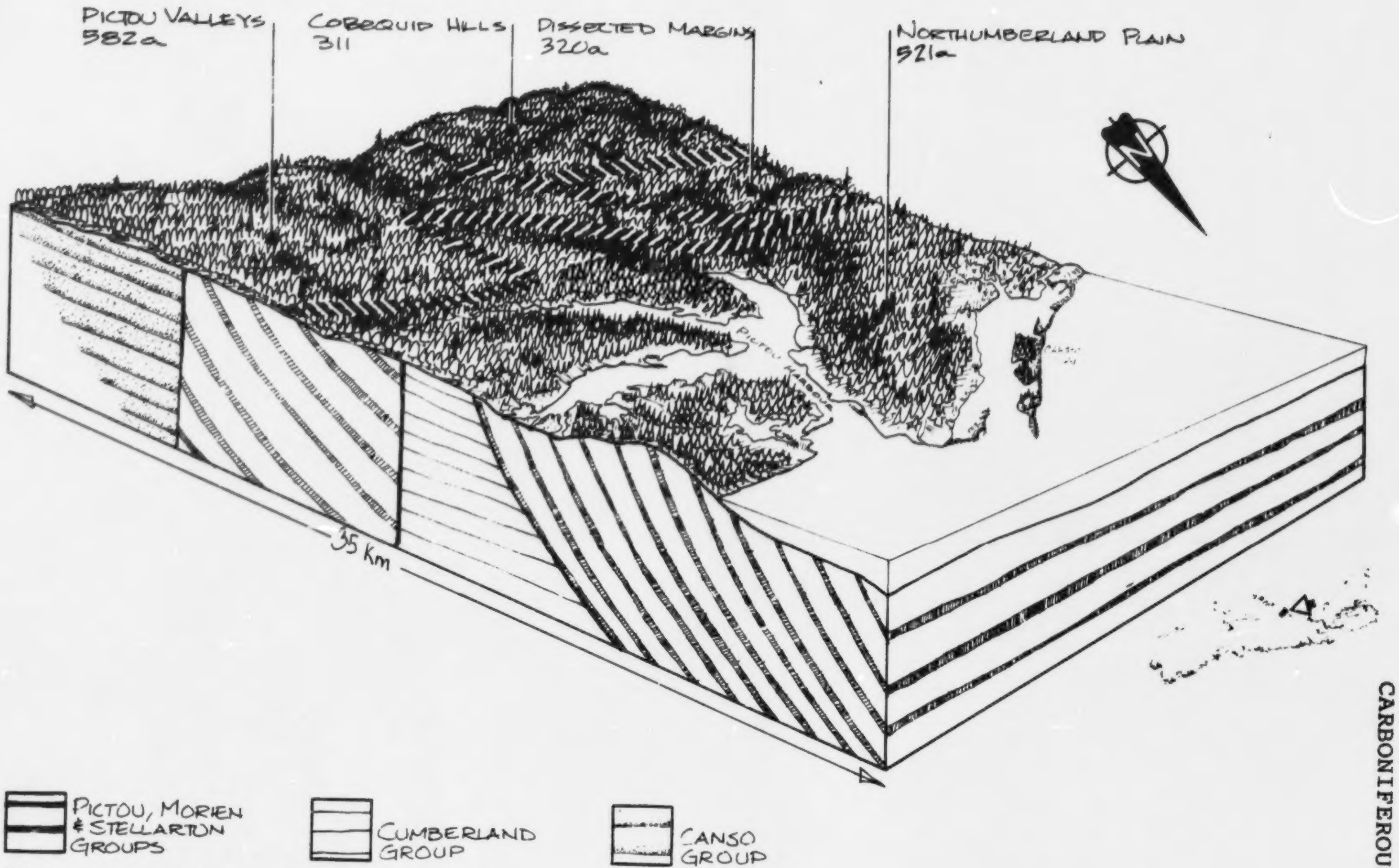

PICTOU VALLEYS
582a
COBEQUID HILLS
311
DISSECTED MARGINS
320a
NORTHUMBERLAND PLAIN
521a
N
PICTOU HARBOUR
35 Km
PICTOU, MORIEN & STELLARTON GROUPS
CUMBERLAND GROUP
CANSO GROUP

Plate 12. Pictou Basin
The three rivers (West, Middle and East) of Pictou drain to the Northumberland Strait across the low-lying Northumberland Plain (531) through the drowned estuary of Pictou Harbour. The three valleys are deeply eroded into the Carboniferous rocks (582) which are bounded on the west by the Cobequid Hills (311) and their Dissected Margins (320).

UNIT 583: ANTIGONISH UPLANDS

a) South River
b) Lakevale

GEOLOGY AND GEOMORPHOLOGY

South and north of the town of Antigonish are two areas of upland which are underlain by Devonian to Middle Carboniferous strata of varying character. They included resistant Horton strata, easily eroded Windsor deposits and slightly more resistant Canso and Riversdale strata. Some volcanic rocks also occur. The areas are cut by faults and are elevated and dissected. They represent a transitional zone between the coastal lowland and the uplands to the west and south.

In the South River area a valley extends southwards through Lochaber Lake across the southern uplands to the St. Mary's River estuary. This may have been the course of an ancestral river which flowed northwards from the Scotian Shelf and was superimposed upon the resistant rocks that the valley now crosscuts.

SOILS

(583a - South River)
To the west of this sub-unit Millbrook soils predominate. These soils have developed from gravelly clay loam tills of mixed origin - sandstones, shales and metamorphic rocks. In the centre well-drained Woodbourne soils have developed from shales and sandstones of the Windsor formation. Woodbourne soils are stony to shaly loams. Stewiacke and Hebert soils are common on water deposited materials along stream and river valleys, the former having developed from alluvium and the latter from glacio-fluvial deposits.

(583b - Lakevale)
The soils in this sub-unit tend to be imperfectly drained, either because of the fine textured impermeable subsoil, or because they are underlain by flat lying bedrock. The finest textured soils are Queens (sandy clay loam) and Millbrook (gravelly clay loam). Hansford soils are coarser but also imperfectly drained. The better drained Thom soils are derived from a mixture of sandstones and metamorphic rock. Westbrook soils are found on tills derived from conglomerate.

VEGETATION

This unit falls within Louck's Sugar Maple-Hemlock-Pine zone, at the boundary between two ecoregions - a northerly one in which softwoods predominate among scattered hardwood stands, and a more southerly one in which tolerant hardwoods (H.27) are found on a wider range of sites. In the western part of the unit Sugar Maple, Yellow Birch and Beech are common, with spruce, Hemlock, pine, Red Maple and birch (H.24) on less well drained sites. Oldfields regenerating in White Spruce (H.26) are common. As one approaches Cape Breton softwoods became more prevalent.

FAUNA

This unit provides mainly forested habitats, with cliffs along St. Georges Bay. There is virtually no information on small mammals occurring in this unit but diversity is probably moderately high.

SITES OF SPECIAL INTEREST

Provincial Parks and Park Reserves

- Linwood

UNIT 584: AINSLIE UPLANDS

GEOLOGY AND GEOMORPHOLOGY

The Ainslie Uplands cover a large area of southwestern Cape Breton from St. George's Bay to Lake Ainslie. The geology is dominated by Horton Group deposits which have been thrown into broad folds trending northeast-southwest.

The area is on the uptilted side of the planation surface and has been deeply eroded. Almost all the strata younger than those of Windsor age have been stripped off. The remaining Windsor Group strata, which still attain a total thickness of 2,500 feet (750 m), are preserved in long synclines and fault blocks southwest of Lake Ainslie and east of the Mabou Highlands. In this area, on the southern end of the Highlands, there are also some volcanic rocks of Devono-Carboniferous age.

Topographically the Ainslie Uplands are hilly and fairly rugged with the hills forming a visual continuum from the Creignish Hills to Lake Ainslie. All the major rivers, the Mabou, Southwest Mabou, Mull and Black Rivers, exploit the bands of Windsor strata lying between the long ridges of Horton rocks and form a roughly rectangular drainage pattern. The Mabou River flows in a faulted block of Windsor strata and reaches the Northumberland Strait through a drowned estuary.

Glacial deposits which were brought down from the Cape Breton Highlands by glaciers and glacial streams mantle the area. Lake Ainslie itself has been dammed by glacial gravels which can be seen as ridges near Strathlorne. The westward extension of the lake, Loch Ban, is shallow and bordered with peat deposits which can be found far up Black River along a flat low belt of Windsor strata. Coarse glacial gravels can be seen on the lower slopes of the Mabou Hills. Inland, fine sandy deposits in a valley between Loch Ban and the sea ascend to over 500 feet (150 m) above sea level.

SOILS

On the higher elevations - up to 650 feet (200 m) - Diligence, Woodbourne and Westbrook soils predominate. Diligence soils have developed from gray shales, while Woodbourne soils have developed from reddish-brown sandstones and conglomerates. Falmouth and Queens soils are chiefly found on low-lying areas below 100 feet (30 m), and overlying or adjacent to gypsum deposits. All of these soils, with the exception of Westbrook, are imperfectly drained loams or clay loams over relatively impermeable clay loam tills. An interesting feature is the large area of sand between Lake Ainslie and the sea. Coarse, well drained Canning soils have developed on this sand plug.

VEGETATION

As the highest and one of the most northerly units in the Carboniferous Lowlands Region, the Ainslie Uplands are part of the Sugar Maple-Yellow Birch-Fir zone which encompasses many of the highlands in Nova Scotia (Region 300). This zone is distinguished by predominantly hardwood forest (H.27) in which Sugar Maple, beech, Yellow Birch and Red Maple occupy the upper slopes and high ridges. Balsam Fir and White Spruce cover the upland flats and valley slopes. Black Spruce and Larch are found on the extensive areas of clay soils throughout this area. Oldfields regenerating in White Spruce (H.26) are common.

FAUNA

Small mammal diversity is relatively high.

SITES OF SPECIAL INTEREST

Strathlorne: (Route 19)
- a hummocky ridge of sand which dammed a river formerly flowing to Inverness and created Lake Ainslie. The lake now drains northward into the Margaree River.

Mabou Harbour Mouth to West Mabou Harbour
- gypsum area

Black River (IBP Proposed Ecological Site 12)
- alkaline sphagnum bog including a number of rare plants such as *Rhynchospora capillacea*, *Carex gynocrates*, *Elcocharis pauciflora* var. *fernaldii*, *Salix candida* and *Galium tinctorium*.

Provincial Parks and Park Reserves
- North Ainslie
- Long Point
- Mabou
- Ainslie Point

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T25 Sea Level Change.

UNIT 585: IONA UPLANDS

GEOLOGY AND GEOMORPHOLOGY

In Cape Breton Horton strata are not found east of the Great Bras d'Or Channel. In eastern Cape Breton the earliest Carboniferous deposits are represented by the Grantmire Formation. These strata are probably the same age as the Horton Group but are made up of coarser material: conglomerates , grit and coarse sandstone. The Iona Uplands are predominantly underlain by Grantmire strata deposited as alluvial fans directly on to the ancient granites and schists of the Boisdale Hills when they stood on the side of the intermontane basin.

The Iona Uplands area divided into two areas 585a) Grand Narrows and 585b) Sydney River. In both areas the Grantmire rocks form resistant shoulders on the upland block of the Boisdale Hills and give steep slopes rising directly from the Bras d'Or Lowlands. The elevations reach a maximum of 650 feet (200 m), in keeping with the location of this area on the tilted planation surface.

585a) Grand Narrows

This area includes a section of upland between St. Patrick's Channel and the Great Bras d'Or made up of both Horton and Grantmire strata. It is extensively crosscut by faults and stands as a hill with a fault scarp on the east and a more gradual descent to the Submerged (Bras d'Or) Lowland on the west.

585b) Sydney River

This area is mantled by thick glacial deposits, kames, eskers and outwash gravels, which partly fill the river valley and create a series of shallow lakes connected by narrow channels.

These deposits are evidence of the existence of a lobe of ice in East Bay which extended from the Submerged (Bras d'Or) Lowland during the late stages of the Wisconsin glaciation. As the ice melted, streams carried outwash material towards the Cabot Strait.

SOILS

(585a - Grand Narrows)

In this area soils are mostly well drained Westbrook sandy loams developed from conglomerates, with imperfectly drained

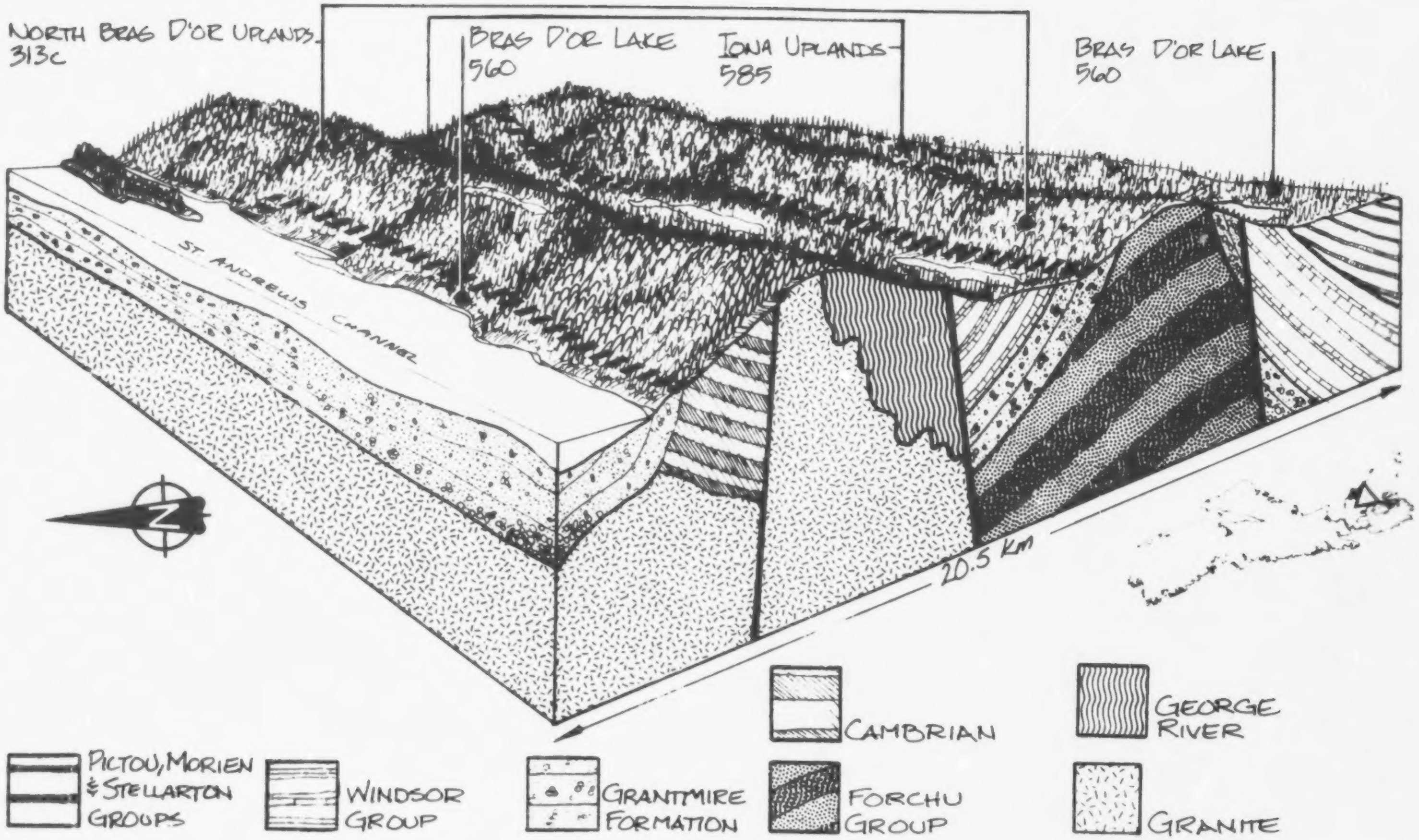

NORTH BRAS D'OR UPLANDS 313C
BRAS D'OR LAKE 560
IONA UPLANDS 585
BRAS D'OR LAKE 560
ST. ANDREWS CHANNEL
N
20.5 Km
PICTOU, MORIEN & STELLARTON GROUPS
WINDSOR GROUP
GRANTMIRE FORMATION
CAMBRIAN
FORCHU GROUP
GEORGE RIVER
GRANITE

Plate 13. St. Andrews Channel
The Iona Uplands (585) are a transitional, hilly, area of Carboniferous rocks between the upland fault blocks of ancient metamorphic rocks (313) and the easily eroded Windsor Group rocks which fringe the Bras d'Or Lake, Submerged Lowland (560).

Millbrook clay loams. Small areas of Woodbourne silt loams also occur.

(585b - Sydney River)
Again Westbrook soils are dominant, with areas of imperfectly drained Debert silt loam (often with a cemented layer). Queens soils, a clay loam, are found at Point Edward. Some areas of coarse Hebert soils occur on outwash sands and gravels.

VEGETATION — See District 560 - Submerged (Bras D'Or) Lowland

SITES OF SPECIAL INTEREST

Blacketts Lake to Sydney River
- kames, eskers and outwash gravels along the river valley.

Provincial Parks and Park Reserves
- Barra Forest
- Iona

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits

590 Dissected Plateau

GEOLOGY

District 590 is underlain by resistant early Carboniferous strata which flank the Cape Breton Highlands. The rocks are predominantly coarse early Horton deposits, but in many places along the western side of the Highland Early Carboniferous lava flows are found. In places these reach 1,000 feet (300 m) in thickness.

These Early Carboniferous deposits are in some places in fault contact with the Highlands and in others have been deposited directly on to the surface. Immediately at the contact, the Carboniferous strata are often tilted up or domed indicating that the Highland block moved up vertically through them. In some places away from the contact domed hills of Early Carboniferous strata occur which may conceal blocks of the ancient rocks underneath them. Examples of these hills are Hunters Mountain and Salt Mountain. Elsewhere, these resistant strata form shoulders high on the slopes of the Highland. The Cape Breton Highlands may once have been covered by many thousands of feet of Carboniferous rocks which have been stripped away leaving these resistant remnants. Occasionally pockets of Middle Carboniferous strata remain, such as those of the Riversdale Group around Chimney Corner, but these have generally been preserved in downfaulted blocks. Similarly the Windsor strata which are found here and there around the margins of the Highlands lie almost entirely in faulted valleys.

GEOMORPHOLOGY

The district is dissected by faults which lie predominantly northeast-southwest, parallel to the fold direction typical of the Carboniferous Basin, and to the general structural trend in Cape Breton. These faults are usually followed by river valleys. Generally the terrain is elevated and rugged, reaching 1,000-1,150 feet (300-350 m) in places along the slopes of the Highlands.

The district is heavily mantled with glacial deposits which were washed down during deglaciation of the Highlands. These are thickest close to the Highland slopes, particularly where the ice followed fault valleys such as those of the Margaree and Middle Rivers.

A wave-cut notch at 20-30 feet (6-10 m) above the high tide mark is prominent around Cape St. Lawrence from Cheticamp to Cape North and beyond to Cape Smokey. In places it is overlain by peat which is of early Wisconsin age.

The District is divided into two units on the basis of morphology, the Margaree Plateau (591) and the St. Lawrence Slope (592).

ASSOCIATED TOPICS

T2 Introduction to the Geological History of Nova Scotia, T25 Sea Level Change.

UNIT 591: MARGAREE PLATEAU

GEOLOGY AND GEOMORPHOLOGY

The Margaree Plateau is an area of dissected upland that sweeps southward from the Highlands to Lake Ainslie in the southwest and to the Submerged (Bras d'Or) Lowland in the southeast.

Within the folds of resistant Horton strata there are down faulted blocks of Windsor Group rocks in several areas. The valleys of the Northeast Margaree, the Middle River and the Baddeck River have all been eroded from Windsor strata.

The escarpment on the west side of the Northeast Margaree valley is straight for over 9 miles (15 km). It is in line with other valleys across the Highland and with the Aspy Fault valley at Cape North.

When it reaches the Windsor strata the Northeast Margaree valley widens out, flowing between high hills. The floor of the valley is covered with glacial sands and gravels and a flood plain with oxbow ponds and terraces has developed. At Emerald the river turns 90° to the west, cuts through a band of Horton strata and flows to Margaree Forks. Originally it probably flowed southwards to the Middle River and St. Patrick's Channel but this exit was blocked with glacial drift. The old river valley is now occupied by a string of lakes, Harvard, First O'Law and Second O'Law. Beyond Margaree Forks the river flows through another strip of Windsor strata before entering its drowned estuary at Margaree Harbour.

The hilly terrain continues to the Baddeck area. There it is intersected by the Windsor lowland through which the Baddeck River flows to its drowned estuary at Nyanza Bay. Glacial deposits are found along most of the major rivers. At Middle River and Skye River (further south) the gravels contain Mastodon teeth.

SOILS

Soils in this unit are mapped only as Rough Mountainland. However, it is known that the soils are, for the most part, surprisingly deep, with some smooth compressed silts, supporting the theory that the area was not extensively glaciated. It is probable that the soils share at least some of the characteristics of those described in Unit 584, Ainslie Uplands.

VEGETATION

This Unit forms part of Louck's Sugar Maple-Yellow Birch-Fir zone. However, while the Ainslie Uplands have a rolling, hilly terrain, the Margaree Plateau is more level. White Spruce is common in old fields and pastures which have been recolonized. On the flatter, upland areas there is Balsam Fir and Black Spruce, mixed with intolerant hardwood. Better drained, rolling areas have more tolerant hardwoods; Sugar Maple, Yellow Birch and Beech (H.27) with a mixture of Balsam Fir.

FAUNA

This unit provides eagle nesting habitat and an important post-breeding concentration area.

SITES OF SPECIAL INTEREST

Northeast Margaree Valley
- fault scarp on the west side of the valley, sinkholes in areas of karst topography, river terraces

Baddeck River (west side north of Melford)
- a fossil valley containing Windsor strata

St. Anns Harbour
- gravel and sand bars nearly block the harbour entrance. The narrow gap is crossed by a cable ferry. From Kelly Mountain lookoff (geological highway map site 74) the old positions of the sand bar can be seen as ridges.

Piper Glen (IBP Proposed Ecological Site 13)
- mature mixed forest

Lake O'Law (IBP Proposed Ecological Site 14)
- old growth deciduous and coniferous forest.

Provincial Parks and Park Reserves
- St. Anns
- Whycocomagh
- Scotsville
- S.W. Margaree
- Doyle's Bridge
- Lake-O-Law

ASSOCIATED TOPICS

T51 Birds of Prey.

ASSOCIATED HABITATS

H31 Balsam Fir Forest.

UNIT 592: ST. LAWRENCE SLOPE

GEOLOGY AND GEOMORPHOLOGY

The St. Lawrence Slope is a narrow band of resistant Early Carboniferous rocks which shoulder the Cape Breton Highland massif along its west side from Margaree Harbour to Cape North. It is physically separated into three areas:

a) Squirrel Mountain
b) Polletts Cove
c) Meat Cove

In the Squirrel Mountain area the strata are dominated by the Early Carboniferous volcanic lavas. These are very resistant and the slope from the Highland Plateau drops steeply to the coast where it meets a narrow coastal plain (541b). At Corney Brook all the main rock groups in this part of Cape Breton are exposed within a short distance of one another. The Horton strata contain angular pieces of the basement rock.

The Polletts Cove area lies beside Pleasant Bay and presents unremittingly steep slopes which form a continuum with the underlying Highland block. Pleasant River flows along a fault and across a small triangle of Windsor Group rocks before reaching the Northumberland Strait.

At Meat Cove there is a larger area of Early Carboniferous strata, but again since these rocks are almost as resistant as the granites and gneisses, the landscape remains steep and rugged with high cliffs bordering St. Lawrence Bay.

VEGETATION

Softwoods predominate - spruce, Hemlock, pine (H.25) and fir, with maple and birch (H.24). Pure stands of White Spruce (H.26) occur on old fields, with better stands of tolerant hardwoods, (Sugar Maple, Yellow Birch and beech, H.27) on better drained slopes and rich intervale soils.

FAUNA

A number of barachois ponds are found in this unit. Freshwater habitats are somewhat more alkaline and support a diverse aquatic fauna. The unit also provides some scattered eagle breeding habitat. Aspy Bay is frequented by a wide variety of birds from spring to fall. A moderate number of Black Guillemots are believed to breed in part of Bay St. Lawrence.

SITES OF SPECIAL INTEREST	Corney Brook - a complete section of local strata North Aspy River (IBP Proposed Ecological Site 21) - old growth deciduous forest.

ASSOCIATED TOPICS

T26 Coastal Landforms, T53 Seabirds.

ASSOCIATED HABITATS

H3 Rocky Shore, H19 Cliff .

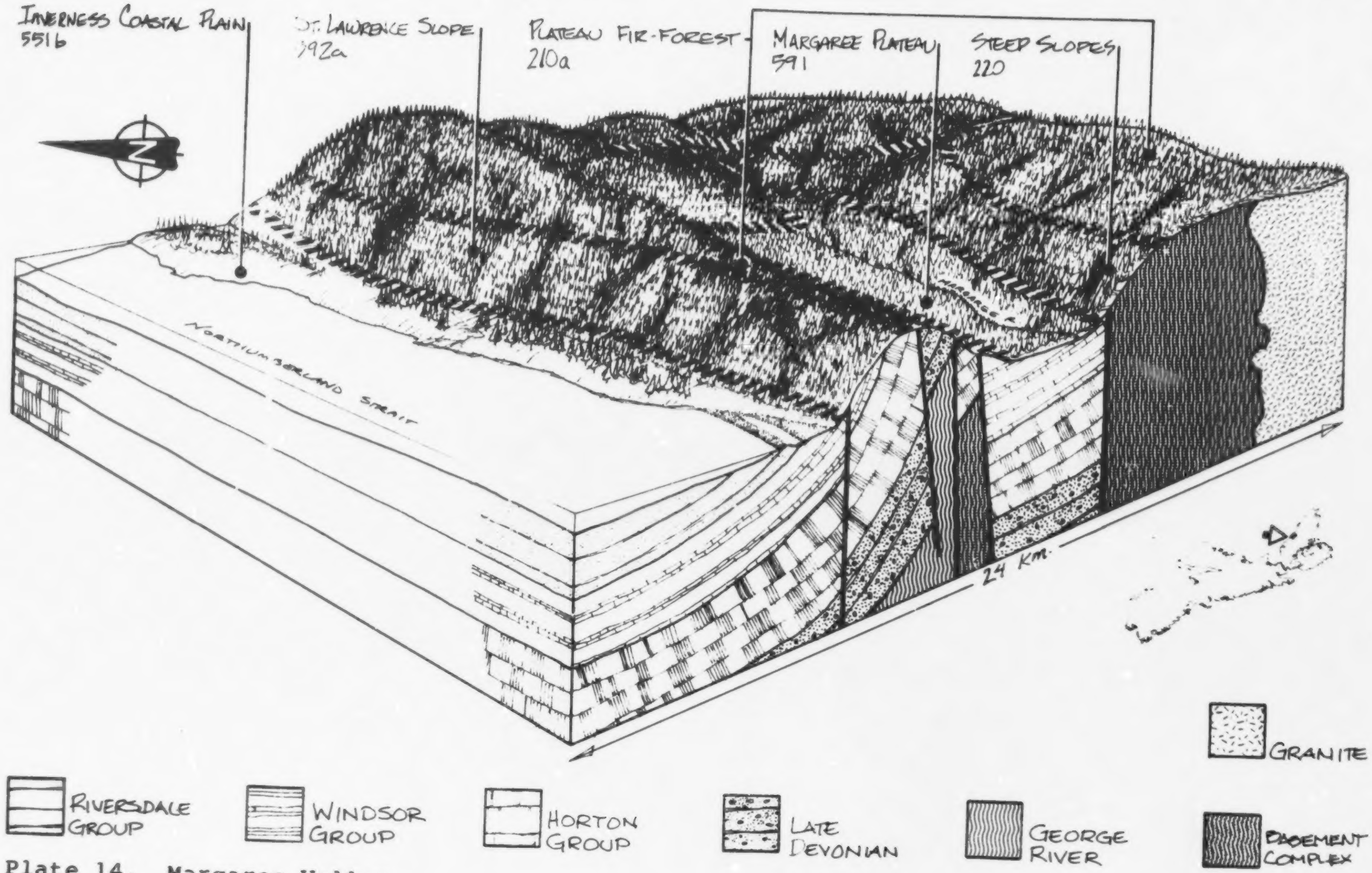
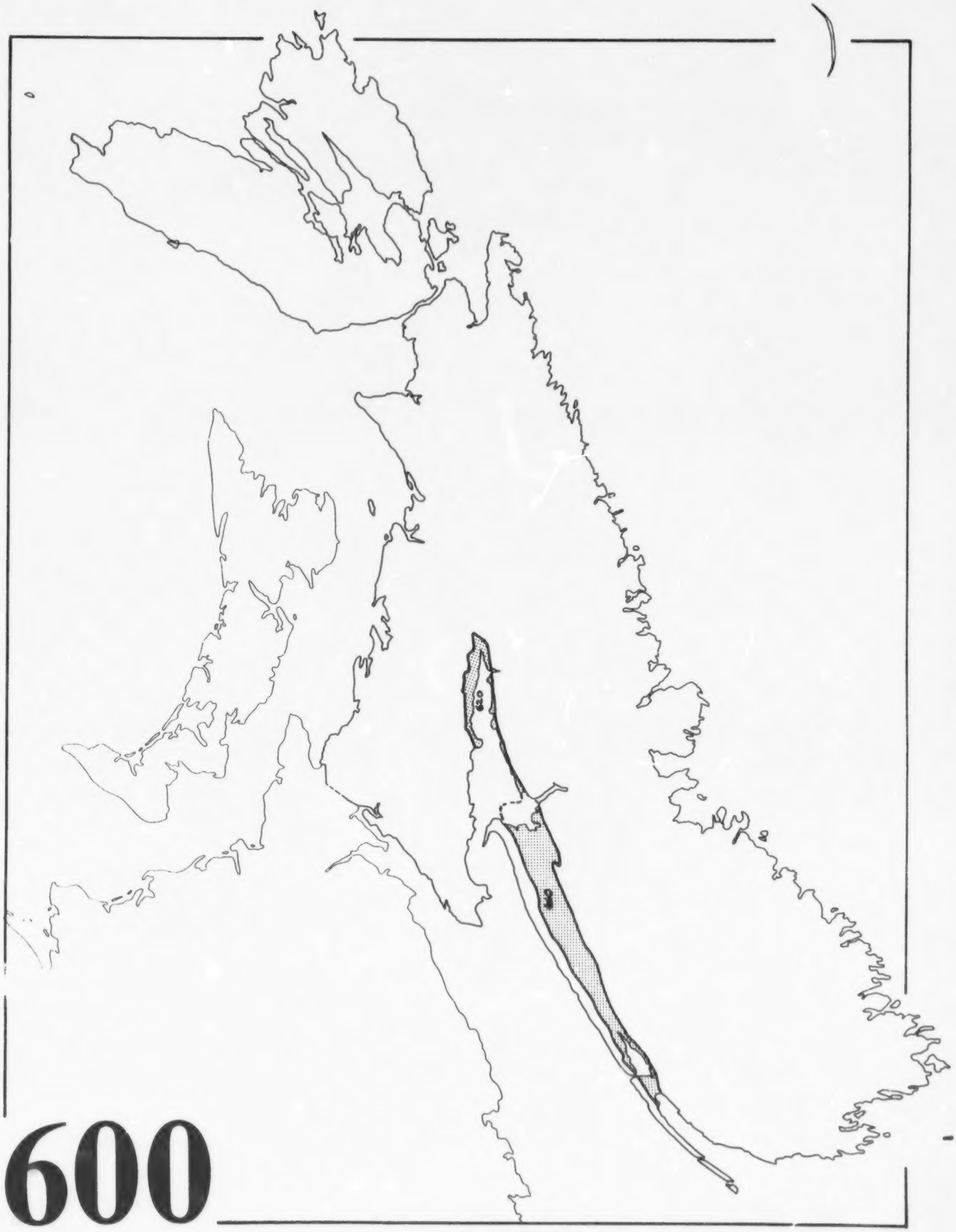

Inverness Coastal Plain
551b
St. Lawrence Slope
592a
Plateau Fir-Forest
210a
Margaree Plateau
591
Steep Slopes
220
N
Northumberland Strait
24 Km.
Granite
Riversdale Group
Windsor Group
Horton Group
Late Devonian
George River
Basement Complex

Plate 14. Margaree Valley
Windsor Group rocks, including gypsum, are preserved in downfaulted sections now occupied by the Margaree River and the Inverness Coastal Plain (551). Horton conglomerate and sandstone comprise the deeply dissected Margaree Plateau (591) and the St. Lawrence Slope (592) which forms a shoulder to the Plateau Fir-Forest (210). The St. Lawrence Slope is the soft rock equivalent of the hard rock Steep Slopes (District 220).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600 TRIASSIC LOWLANDS

GEOLOGY AND GEOMORPHOLOGY

The distinctive red beds that fringe the Cobequid Bay and extend underneath the Annapolis - Cornwallis Valley belong to the Triassic Lowlands. They are made up of weakly cemented easily eroded sandstones and sandy shale overlain by glacial deposits of varying character.

The red beds were deposited under arid conditions in a narrow hill-fringed basin while Nova Scotia was still part of Pangea. The early deposits washed down from South Mountain and Cobequids were coarse sands which were later consolidated into a crumbly sandstone (Wolfville Formation). Much of the basin was then flooded with lava as volcanoes became active in the Fundy region. Later faulting and subsidence created a spoon-shaped depression or trough in which the sandstones, shales and basalt dip at 5 degrees - 10 degrees towards the centre line of the Minas Basin. The trough is now largely occupied by the sea.

The northern side of the trough is downfaulted. The master fault is probably the Cobequid Fault but the present boundary of the Triassic deposits is the Portapique Mountain Fault. Along this northern margin the strata are more steeply inclined than those to the south and in places are even gently folded.

During the long period of erosion up to and including the Cretaceous much of the basalt was removed. Some still remains as a protective cap on the sandstones but to the north, east and south wide bands of soft sandstone became uncovered. Rapid erosion then ensued as a river system developed in the trough followed by glacial scouring and finally marine invasion. Much of the Triassic Lowlands Region is now covered by water. The largest area still above sea level is the eastern part of the Annapolis - Cornwallis Valley which though undergoing rapid erosion is protected somewhat by its flanks of resistant rock; the North Mountain basalt and South Mountain granite. The western end of the valley underlies St. Marys Bay. Elsewhere the Triassic deposits fringe Cobequid Bay forming low, rapidly retreating sea cliffs fronted by wide, wave-cut platforms and mud flats.

CLIMATE

The climate of the Triassic Lowlands is inland in character, because of the shelter provided by North and South Mountains. It is, however, modified at both the Digby and the Minas Basin ends by marine influences. The main climatic features in this region are the warm, early spring; the hot summers with less precipitation than elsewhere; and the frequency of clear skies.

Winters are cold but not severe. The January daily mean temperature is 21°F (minus 6°C), compared to 19°F (minus 8°C) in northern Nova Scotia, and 25°F (minus 5°C) in southern Nova Scotia. Mean daily temperatures rise above freezing in late March, with the warming trend moving west to east. Spring temperatures are warm and by July the mean daily temperature is 64°F (18°C). Mean daily temperatures fall below freezing during the first week of December. The western end of the Region, under the influence of the Bay of Fundy, is slightly milder in winter and cooler in summer.

Total annual precipitation at the eastern end and extreme western end of the Region is less than 48 inches (1,200 mm). Toward the centre of the valley it is somewhat higher between 48 and 56 inches (1,200 and 1,400 mm). Snowfall is moderate, being over 100 inches (250 cm) in the centre of the region and along the north shore of Minas Basin, and decreasing westwards. The Digby area receives less than 60 inches (150 cm). The snow cover season lasts longer at the eastern end than at the western end, by a difference of approximately thirty days.

Most of the Region is relatively protected, by North Mountain, from seasonal fog, mist, and low cloud of marine origin, with the result that clear sunny days are more frequent than in coastal areas.

In terms of bioclimate this is the most favoured part of the province. The frost-free period and the growing season (145 and 195 days respectively) are fairly long, with an accumulation of over 2,400 growing degree days. Summer precipitation at the eastern end of the Region is lower than elsewhere, and this combined with the prevalence of coarse sandy soils can lead to droughty conditions in some years. The warm temperatures and low elevations result in high potential evapotranspiration (a mesothermal climate). Poor air drainage on the valley floor creates frost pockets.

SOILS

The soil map reveals a complex mix of soil types in this Region. This is attributable to the variety of parent materials, and to a range of glacial outwash and post-glacial marine deposition processes. The soft red Triassic sandstones are easily eroded and have formed deep, coarse soils. Along the footslope of North Mountain the parent material often includes a mixture of basaltic rock. Along South Mountain the till is modified at the eastern end by gray and black slates and shales, and at the western end by granite. Most of the soils are well or excessively drained sands and sandy loams. Some limited areas of imperfectly drained soils have developed on finer water deposited materials. At either end of the Annapolis Valley and at the head of Cobequid Bay extensive areas of salt marsh have been dyked. Small areas of organic soils are found scattered all along the valley floor and along the south shore of Minas Basin, but not along the north shore.

ETATION

The Triassic Lowlands are part of Louck's Red Spruce - Hemlock - Pine Zone in which red spruce and hemlock, now heavily cut, once attained their greatest prominence. This in turn is divided into two forest ecoregions. The Annapolis Valley is part of the ecoregion covering the western interior, in which coarse soils predominate and Red Oak is a common species. To the east slightly heavier soils occur and Red Maple replaces Red Oak as the successional species after fire.

The main factors influencing the regional vegetation are the warm summers, the well-drained soils, and the extensive disturbance by both cutting and fire. The remaining stands are mostly coniferous, but there were probably more hardwoods on the valley floor before lumbering. The climate suits shade-tolerant hardwoods, but the precipitation is just high enough to give spruce and Hemlock the advantage (H.25). Red Spruce, Hemlock, White Pine, Balsam Fir, with Red Oak in the western portion, and Black Spruce and Red Maple to the east, are the main species. Extensive areas are cleared for agriculture, and oldfields are common, usually regenerating in White Spruce (H.26). In the Annapolis Valley extensive pine stands (H.28), growing on the sand plains in the centre of the valley, are a very distinctive feature of this Region. They are often found in association with heath barrens. Dykeland and salt marsh plant communities are found along the coast.

FAUNA

This Region provides a wide range of terrestrial and aquatic habitats, and productive inter-tidal habitats. Terrestrial habitats include a diverse mix of open land and forested areas. The fauna of this Region includes a number of more southerly and opportunistic species, often associated with agricultural areas (for example, fox and skunk). The mud flats, salt marshes, dykelands and estuaries are important breeding and staging areas for waterfowl and migratory shorebirds such as semipalmated sandpiper. Together with wet meadows the saltmarshes and dykelands are amongst the largest areas of suitable habitat in Nova Scotia for the Arctic Shrew. The marine life of the Minas Basin is special because of warm temperate species some of which are endemic or rare in a Canadian context (eg. the clam, Barnea truncata).

The Triassic Lowlands Region has two Districts:

610 Annapolis Valley
620 Cobequid Bay

ASSOCIATED TOPICS

T7 The Nova Scotian Desert, T8 The Triassic Basalts and Continental Rifting, T12 Tertiary Drainage Patterns, T13 Glaciation, T20 Nova Scotia's Climate, T22 Tides, T25 Sea Level Change, T26 Coastal Landforms, T34 Biological Environment, T43 Plant Communities in Nova Scotia, T51 Shorebirds.

ASSOCIATED HABITATS

H6 Mud Flat, H7 Salt Marsh, H18 Oldfield, H19 Cliff, H25 Spruce, Hemlock, Pine Forest, H28 Pine Forest.

610 Valley

GEOLOGY

The Annapolis Valley extends from the eastern end of St. Marys Bay in the west to the mouth of the Cornwallis River in the east. It is approximately 80 miles (135 km) long and 2-7 miles (3-11 km) wide.

Early Fluvial Erosion

The valley has been carved out by river action and deepened by glacial scouring. When the sandstones were first exposed, as the basalt wore away, rivers flowed at right angles across it. They rose on South Mountain, flowed north across the present valley and North Mountain before discharging into centre of the river which flowed down the Bay of Fundy. The sandstone wore away faster than the basalt and when the ends of the valley became open to the sea the drainage was diverted to the west and east leaving "wind" gaps across the North Mountain eg. the gap north of Melvern Square.

Sandstone is infrequently exposed within the valley because it breaks down so readily to form a sandy soil. However, some can be seen on the slopes of South Mountain in the beds of rivers and resting upon the older rocks. Outcrops of the overlying, younger, Blomidon Formation which are adjacent to the basalt on the north side of the valley are covered by glacial deposits or scree slopes. At the ends of the valley where marine erosion has removed the overburden red cliffs can be seen; along the face of Cape Blomidon (the lower slope exposes the Blomidon Formation); on the north shore of the Annapolis Basin at Thorne Cove and near Port Wade; and in the bluffs at Rossway. At Kingsport on the Minas Basin excellent exposures of the Triassic Wolfville sandstone occur which contain fossil plant roots and occasional reptile bones. Since the sandstones lie underneath the basalt and dip northwards no outcrops are found on the north shore of North Mountain.

Glacial Deposits

As the ice retreated after the last glaciation sea level rose and the land surface rebounded from its depressed position. In western Nova Scotia and the Bay of Fundy area sea level rose faster and encroached inland. The beaches, marine deltas, elevated shorelines, sand spits and bars which formed at that time can now be seen raised well above sea level in many places along the Annapolis - Cornwallis Valley. The average elevation is 50-100 feet (16-29 m) above sea level but often beaches are found at different heights in the same vicinity. These perhaps have different ages or represent features established along a temporary shoreline as glacial water was impounded against the coast or in a basin. Raised beaches and terraces are best seen in Digby County at the mouths of rivers and around the lower part of the Annapolis Basin.

Glacial outwash deposits are also preserved in this area and near Kentville. Windblown sand, dunes and loess possibly from glacial outwash deposits, is found between Kingston and Greenwood. Kentville lies on the edge of the sand area.

Present Drainage

The Annapolis - Cornwallis Valley is drained by two main rivers, the Annapolis flowing west and the Cornwallis flowing east. In both cases the lower reaches have been drowned as sea level has risen during the past 4,000 years or so. During this period St. Marys Bay formed and the Annapolis Basin was flooded as the sea broke through the river-cut gap at Digby Gut.

Both the Annapolis and Cornwallis Rivers have developed extensive marshes in their lower reaches. The wide fertile valley north and east of Kentville which opens onto the Minas Basin has been created by five rivers: the Gaspereau, Cornwallis, Canard, Habitant and Pereau. The flood plains of these meandering rivers are separated by low ridges and are protected from tidal incursions only by the system of dykes originally built by the Acadian farmers eg. near Port Williams. Grand Pré was probably once a meander in the Cornwallis River with Long Island Head and Boot Island forming part of the northern bank of the flood plain. At some time the river swung northwards forming a new meander between Star Point and Long Island Head. The old meander silted up. Rising sea level has now drowned the lower reaches of the river forming a wide estuary west of Grand Pré.

SOILS

The soils in this unit have formed on parent materials from various exposed geological strata, and on water deposited materials. The finest textured strata are uppermost and on this soft Triassic shale well drained soils of the Pelton series have developed on the footslopes of North Mountain. Coarser sandstones from the middle strata exposed on the valley floor have produced the deep Woodville and Berwick sandy loams. The lowest strata exposed are a fine grained conglomerate from which the Somerset series (a well drained loamy sand) has developed. In the centre of the valley there is a complex water deposited series of sand flats. Associated well drained soils are Canning, Cornwallis and Nictaux, while Debert, Kingsport and Lawrencetown are imperfectly to poorly drained. Alluvial Cumberland soils have developed beside streams and rivers, and imperfectly drained Fash soils have developed on lacustrine or marine clays in the central part of the Annapolis River drainage basin. Along the south slope there are numerous beach terraces of slaty gravel origin from which Torbrook and Nictaux soils have developed. On the lower slopes well drained Morristown soils have formed from slaty parent materials, while Bridgetown soils have developed from a mixture of Carboniferous sandy loam till brought from the north, and locally weathered granite and quartzite. Organic soils are scattered through the valley - the most notable example being the large Caribou peat bog located on the watershed divide between the Annapolis and Cornwallis river systems at Aylesford. Some of the valley floor is wet because of effluent water. In these areas water-loving vegetation such as alders and Larch prevail.

VEGETATION

The Annapolis Valley is most obviously an agricultural region; by the late 19th century extensive clearing had restricted forests to the more marginal sites. Now, however, large areas are reverting to forest growth. Apple orchards were orginally located on the richer tills of the valley slopes. Sugar Maple, Beech, Red Spruce, and Hemlock are typical in later successional stands (H.25 and H.27), White Spruce, fir, pine with the intolerant hardwoods, maple and birch (H.24) are found on more recently disturbed sites. On the dry, sandy soils of the valley floor which are more prone to drought and frost, the maple, oak, birch association is common (H.22). Red Pine, White Pine and Red Oak are found on the valley bottom sand plain. Wire Birch, Red Maple, Red Oak, White Birch and poplar are common post-fire species. Oldfields usually regenerate in White Spruce (H.26) except where wetter conditions favour alder and Black Spruce. Black Spruce and Larch (H.33) are the species found in depressional areas or on poorly drained soils.

Non-forest plant communities are very conspicuous in this unit and include those found in dykelands (H.35) and oldfields (H.18), saltmarshes (H.7) and floodplains (H.12). Scattered Alleghenian floral element habitat is found through the valley.

FAUNA

Wildlife habitats in this unit are diverse and include agricultural lands, orchards, oldfields, woodlands, and heathlands. Freshwater habitats include only few lakes but many slow, meandering streams and rivers. Because of the high Fundy tides coastal habitats consist mainly of extensive inter-tidal areas, both salt marsh and mud flats, and associated dykelands.

Mammals often associated with agricultural areas include a high raccoon population, Red Fox, woodchuck, and increasing numbers of skunk. Muskrat and mink are common. The avifauna also reflects the agricultural character which provides good habitat for pheasant, snipe, woodcock and hawks. The crow population is also high, and the valley provides wintering habitat for Bald Eagle. The dykelands provide good habitat for Gray Partridge (declining) and Short-eared Owls.

The west end of the Minas Basin and the Avon River estuary are nationally important because they support high numbers of shorebirds and waterfowl. Shorebird numbers peak in late summer and early fall, and important sites include Kingsport, Pereau and Evangeline beaches. Waterfowl include Black Duck, Canada Goose, Brant and Teal. Boot Island is a nesting areas for gulls, herons, and cormorants, and also a crow roost in winter.

At the other end of the valley the Annapolis Basin and the Annapolis River are important because they provide migration habitat for concentrations of waterfowl in spring and fall, and because a moderate number of duck remain through the winter. At the head of St. Marys Bay high numbers of shorebirds occur, primarily in August.

SITES OF SPECIAL INTEREST

Melvern Square (north of)
- wind gap

Cape Blomidon
- red sandstone underneath basalt

Thorne Cove, Port Wade, Rossway
- red cliffs and bluffs.

Annapolis Basin
- gravel terraces at river mouths. For example, east of the mouth of Bear River are sands (Torbrook soils) 100 feet (30 m) above sea level.

Smith Cove
- point covered with fine sand, 100 feet (30 m) above sea level.

North of Digby
- obscure beach deposit 90-100 feet (27-30 m) above sea level.

Deep Cove
- gravel deposits 140 feet (42 m) above sea level

Upper Granville
- U-shaped, wave-shaped sand bar.

Wolfville (north of)
- raised beaches

Woodside
- series of sandy mounds extend for 2.5 miles (4 km), near Pereau River, 80 feet (25 m) above sea level. The easterly ones are curved resembling a spit.

Kentville (west end)
- a small lake amongst sand hills is a kettle hole and is surrounded by kames.

Kingston to Greenwood
- kames and esker-like ridges

Avonport Mountain
- view from highway across valley

Kingsport
- excellent exposures of Triassic sandstone with fossil plant roots and rare dinosaur bones and tracks.

Kentville Ravine (IBP Proposed Ecological Site 64)
- old growth hemlock stand and river floodplain, with rich herbaceous flora.

National Wildlife Area
- Boot Island

Provincial Wildlife Management Areas
- Dewey Creek - Minas Basin

Kentville Migratory Bird Sanctuary
Aylesford Bog (Caribou Bog)
Sand barrens near Kingston
Provincial Parks and Park Reserves
- Upper Clements
- Upper Clements West
- Clairmont
- Coldbrook
- Joggins Bridge

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T16 Colonization by Plants, T33 Soil Distribution, T45 Successional Trends in Vegetation, T49 Forest and Open Habitat Birds, T50 Birds of Prey.

ASSOCIATED HABITATS

H5 Sandy Shore, H6 Mud Flat, H7 Salt Marsh, H12 Slow-moving Stream, H18 Oldfield, H22 Maple, Oak, Birch Forest, H26 White Spruce Forest

620 Tidal Bay

GEOLOGY AND GEOMORPHOLOGY

Minas Basin and Cobequid Bay were carved out by rivers which eroded eastwards from the Bay of Fundy cutting a channel along the Minas Passage Fault between Cape Split and Cape Sharp. The shape and profile of the entire Bay was greatly affected by repeated glaciations during the Pleistocene. The floor is smooth and striated like a glacial pavement and is covered by a mantle of loose material up to 30 feet (10 m) thick, some of which is glacial till. At the entrance to Cobequid Bay is a glacially scoured trough.

Around Cobequid Bay the Triassic red beds are nearly horizontal and form a low area with gentle undulations. On the north side of the Bay they attain their greatest width but end abruptly at the Portapique Mountain Fault. The Triassic block has dropped down on the south side of this fault and now lies against older Carboniferous strata. West and east of Truro Triassic deposits lie unconformably against Carboniferous Horton strata. In both areas the Carboniferous strata are harder and form low rolling hills. The boundary with the flat red beds is generally very distinct.

The Shubenacadie and Salmon Rivers which flow into Cobequid Bay both have drowned estuaries and, beneath the river bed deposits, buried river channels. In the Truro area the incised channels of North River and Salmon River can be traced for 3.5 miles (6 km) and 5 miles (8 km) respectively. They merge under the town and continue out to the Cobequid Bay deepening to 130 feet (40 m) and narrowing to 0.5 miles (1 km) following the same course as the present river. These channels, cut in the sandstone bedrock, are filled with fluvio-glacial outwash sands and gravels from the end of the last glacial period, about 10,000 years ago.

Much of the Triassic Lowlands from Truro to the north side of Cobequid Bay is covered by glacial deposits. The Truro sub-basin is filled with outwash sands and gravels carried from the north and east which form a plain elevated to 60 feet (18 m) above sea level; this plain is now dissected by streams. On the north side of the Bay outwash deposits can be seen in the terraces of rivers. At Glenholm the underlying Triassic sandstone is exposed where the gravels have been washed away.

The drainage pattern across the Triassic Lowlands in the Cobequid Bay area is broadly dendritic with the rivers reaching the Bay through drowned estuaries. As sea level continues to rise the soft coastal red beds are being eroded rapidly adding enormous volumes of sediment to the waters of the Bay. This sediment is washed up and down the rivers with the tide and some is deposited in the estuaries as sand bars, for example in the Avon and Shubenacadie River estuaries.

As the coastline retreats coastal marshes are also being eroded. In some cases the remains of fossil forests of beech, pine, Black Spruce and Larch are exposed. These trees were buried by bluish marine clay and boggy marsh when the combined effects of rising sea level and increasing tidal range brought salt water further up low-lying river valleys and over coastal lowlands. Once exposed to tidal action the fossil stumps are quickly destroyed, however new ones are continuously being exhumed. The rapid coastal erosion has created a wave-cut platform 350-1,000 feet (100-300 m) wide bordering the shore. This platform is commonly backed by low cliffs.

SOILS

Hantsport clay loams occur along the narrow strip on the south shore of the Minas Basin. On the western side they are well drained but have imperfect to poorly drained associates to the east. Around the town of Truro, well drained Truro soils have developed from the red sandstone with poorly drained associates covering approximately a third of the area. Gravelly sandy loams of the Harmony series have also formed in this area over gravelly, sandy clay loams. Coarse, Hebert soils on outwash sands and finer textured Cumberland and Stewiacke soils on alluvial materials are found along streams and rivers. Large areas of Acadia soils have formed on dykelands at the head of Cobequid Bay.

VEGETATION

This unit is extensively farmed, but differs from District 610 mainly in terms of the presence of heavier soils. Pine is therefore not such a dominant feature of the vegetation. Scattered Sugar Maple, beech and Yellow Birch (H.27) occur locally on low ridges, but the spruces, fir, White Birch, Red Maple, Hemlock and White Pine (H.24) form relatively stable forests on other sites. Red Maple and Wire Birch replace Red Oak as post-fire species. White Spruce, Red Spruce and Balsam Fir are the usual invaders of oldfields. Heathlands with Jack Pine are found in the Debert area, and the Minas Basin is fringed with areas of salt marsh. Rich intervale sites in the Truro area support Alleghenian floral species.

FAUNA

This District provides a mix of forested, open land and inter-tidal habitats, occupied by a fauna similar to that described in District 610. The south coast of Minas Basin and Cobequid Bay is regionally important because of the significant concentrations of shorebirds in late summer and early fall, and moderate numbers of waterfowl. The north shore of Cobequid Bay is also visited by several thousand shorebirds in August and September, and by waterfowl in spring and fall - mostly Black Duck with some Canada Geese.

SITES OF SPECIAL INTEREST

Walton (Whale Cove)
- Triassic sandstones (Wolfville Formation) unconformably overlie the vertical red siltstones of Horton Group which are exposed at low tide.

Route 215 between Maitland and Cambridge
- the road follows the boundary between the low Triassic coastal fringe and the adjacent rolling Carboniferous hills.

Maitland - Salter Head
- low sandstone cliffs fronted by a wave-cut platform and large sand bars in the estuary of the Shubenacadie River and Cobequid Bay.

Selma
- large sand bar

Victoria Park, Truro
- a river gorge carved during Triassic times in the Carboniferous Horton Group and now being exhumed by Leper Brook. Under the bridge in the park is an angular unconformity between the Horton Group and the younger Wolfville Formation.

Glenholm
- glacial gravel overlying Triassic sandstone in the river terrace.

Debert Waterfowl Sanctuary
- also locality for _Elodea_ waterweed and disjunct Painted Turtle population.

Provincial Wildlife Management Area.
- Debert

Provincial Parks and Park Reserves
- McElmons Pond
- Anthony

ASSOCIATED TOPICS

T51 Wetland Birds and Waterfowl.

ASSOCIATED HABITATS

H5 Mud Flat, H7 Salt Marsh, H24 Spruce, Fir, Pine-Maple, Birch, H27 Sugar Maple, Yellow Birch, Beech.

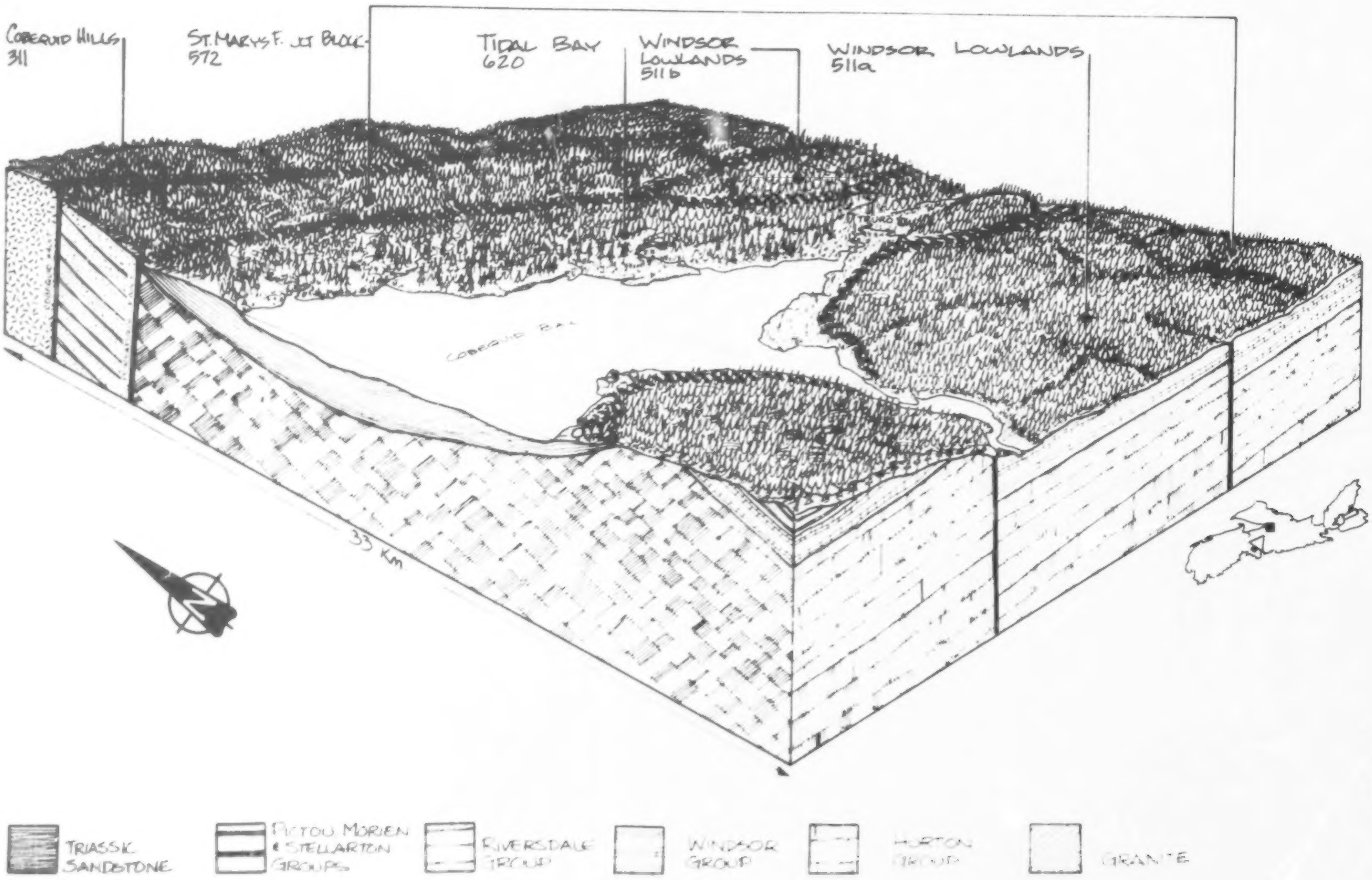
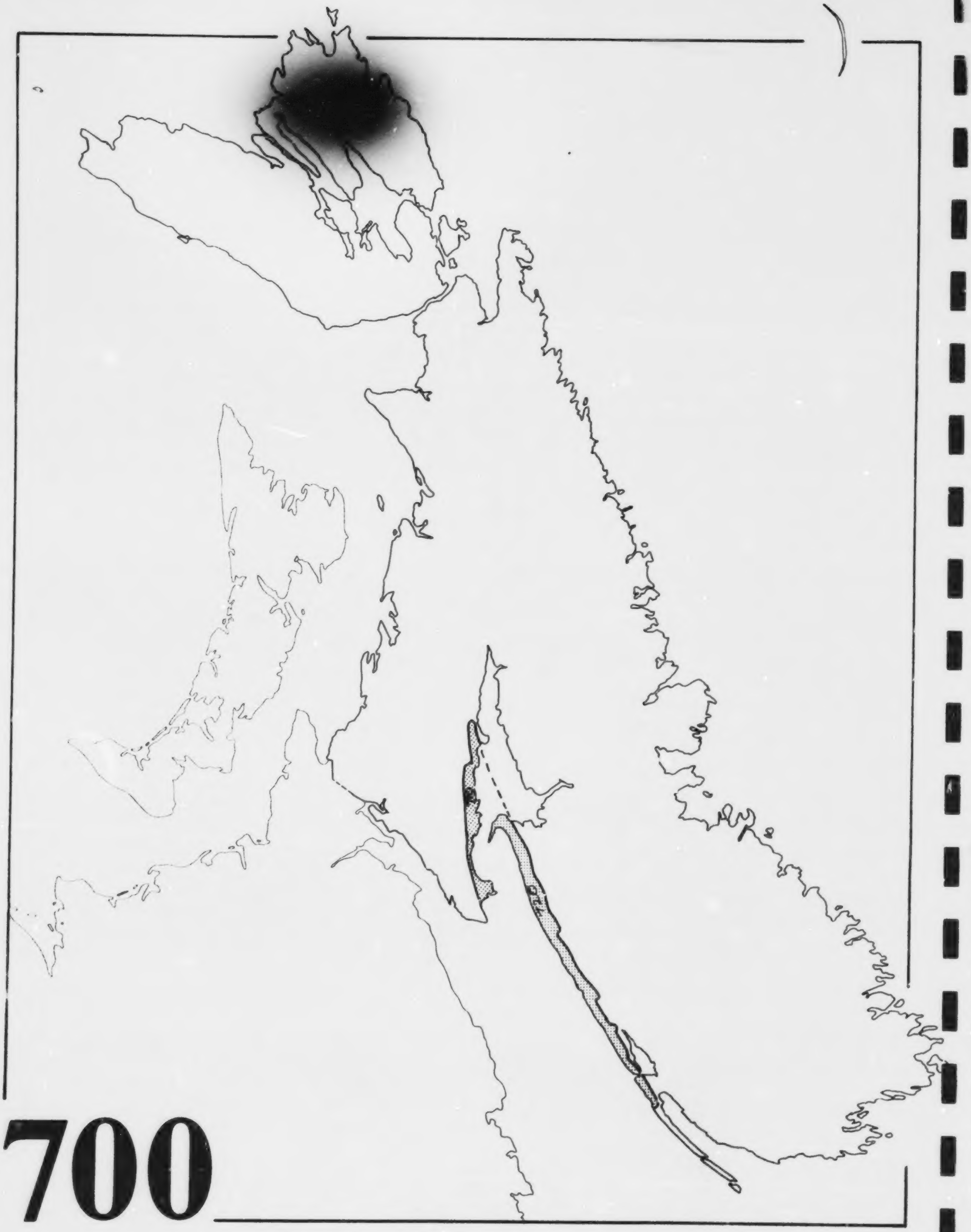

COBEQUID HILLS 311
ST. MARYS F. JT BLOCK 572
TIDAL BAY 620
WINDSOR LOWLANDS 511b
WINDSOR LOWLANDS 511a
COBEQUID BAY
33 Km
TRIASSIC SANDSTONE
PICTOU MORIEN & STELLARTON GROUPS
RIVERSDALE GROUP
WINDSOR GROUP
HORTON GROUP
GRANITE

Plate 15. Cobequid Bay
Very soft, red, Triassic sandstones fringing the Bay (620) are surrounded by the somewhat elevated and more resistant Carboniferous rocks of the Windsor Lowlands Till Plain (511). A westerly extention of the St. Marys Fault Block (572) is a dissected shoulder to the Cobequid Hills (311) from which the short, steep rivers drain to the Bay.



700

700 FUNDY COAST

REGIONAL CHARACTERIZATION

In the central sections of the Bay of Fundy the coastal zone is protected from the extreme climatic conditions of the Atlantic Coast. Cape Blomidon on the south coast and Economy Mountain on the north coast mark the inland limits of this oceanic influence. The Fundy Coast is a climatic and vegetation transition zone dominated by basaltic rocks. Coastal sediments are locally abundant, forming small areas of salt marsh, gravel beaches and mudflats. Wide intertidal platforms have been eroded in both basaltic and sedimentary rocks giving a wide variety of coastal habitats.

GEOLOGY AND GEOMORPHOLOGY

About 200 million years ago the Atlantic Ocean began to open as the continents drifted apart. The gently sloping sandy, arid plain between the Cobequid Hills and South Mountain sank down as the spreading continued. Tensions created by this movement opened rifts in the plain from which basaltic lavas welled up to spread over the sands and gravels. Faulting continued after the lavas had cooled causing fractures, tilting and offsets in the basalt.

Basalt occurred as far east as Portapique and is still preserved in four downfaulted blocks inland of Economy Point. From Gerrish Mountain west, on the north side of Minas Basin, a series of faulted basalt blocks form headlands with vertical cliffs. Inland these are protected areas of sandstones which have been preserved by the basalt. South of Minas Channel the basalt lava flows have formed the continuous ridge of North Mountain. Folds in the underlying sandstone are shown dramatically in Scots Bay. High, continuous, vertical cliffs are found on the outer side of this escarpment; on the coast from Cape Split to Cape Blomidon; and inland from Cape Blomidon to the Annapolis Basin.

Vertical or columnar jointing in the basalt makes it susceptible to erosion. Wide intertidal platforms have been cut at the base of the basalt and even wider platforms in the sandstone bays of the northern shore. Erosion around the margins of the Bay of Fundy is still proceeding very rapidly.

During the glacial period the Bay was deeply scoured by ice and then thickly covered by glacial debris. From 12,000 to 6,000 years ago the sea was probably excluded from the Bay. Before this time the sea had covered the Bay and adjacent land areas up to the ice front forming beach deposits. These old beaches are the "raised beaches" found throughout this Region up to 140 feet (40 m) above present sea level. Then as the ice load was removed the land began to rebound more rapidly than sea level was rising and the Bay floor was exposed. During this period (12,000-6,000 years ago) the rivers flowing into the Bay incised their valleys down to the new base level.

When the last inundation by the sea began 6,000 years ago the conditions for increased tidal amplitude were created by the shape of the Bay. Subsidence of the land and a slowly rising worldwide sea level have caused recent measured sea level increases of 16 inches (40 cm) per century in the outer reaches of the Fundy coast. Rapid erosion of the soft rocks has been accelerated by this rise of relative sea level. Wide inter-tidal platforms, salt marshes, submerged forests and freshwater marshes have formed and large inter-tidal sand bodies have built up.

CLIMATE

Waters in the Bay of Fundy profoundly affect the climate of the adjacent coasts. Extreme tidal-induced turbulence prevents the coastal waters from freezing and, more important, prevents warming of the surface layers in summer. By late summer surface coastal water in the Bay of Fundy is cooler than any other surface water off Nova Scotia's coasts, never exceeding about 54°F (12°C). This same water after crossing warm exposed intertidal sands may reach 68°F (20°C) or more.

Moist summer air masses result in thick fogs over the Bay. These fogs commonly extend to the crest of North Mountain before being dissipated by the heat of the land. While the climate is similar to that of the Atlantic Coast in terms of temperature (moderated with low ranges of temperature) there is not the same exposure to winds (except on some cliffed headlands) and salt spray from ocean swells.

East of the Minas Channel surface waters are considerably warmer, summer fogs are much less frequent, and the coastal climates resemble a modified Annapolis Valley temperature and precipitation regime. The climatic boundary is closely approximated by the eastward limit of basaltic rocks.

SOILS

On the basaltic rocks of the Fundy Coast coarse textured soils, somewhat richer in nutrients than is usual for Nova Scotia's Podzols and Luvisols, are found. Glenmont and Rossway soils are better supplied with both calcium and magnesium than other soils but are low in available posphorous. This simple pattern of soil formation on the North Mountain Basalt Ridge (District 720) is only complicated by patches of reddish glacial till, carried south from the floor of the Bay of Fundy, on which fine-textured Wolfville soils have developed.

By contrast the north Fundy Coast, Basalt Headlands (District 710) has a great variety of soils developed from basalt, sandstone, shale and extensive glacial outwash sands and gravels reworked by higher post-glacial sea levels.

VEGETATION

The Fundy Coast Region shows evidence of being a climatic transition zone between a more inland-type regional vegetation and the true coastal forest although the coastal influence is still strong. Red Spruce is abundant here but is not found in the Atlantic Coast Region. Beech and Sugar Maple are found at higher elevations.

On exposed basalt cliffs arctic-alpine plant communities are found containing some plants with a boreal distribution. Cliff top forests are of the true dense coastal forest type

(H.32) but change within a few feet to a more open hardwood forest with a rich herbaceous understorey.

Coastal waters support sometimes dense growths of marine algae where sediment content is low. Where sedimentary rocks outcrop at the coast, turbidity is high and species diversity is severely restricted.

FAUNA Deer populations are large, particularly, in the Basalt Headlands district which provides wintering range for deer forced from the Cobequid Hills by snow accumulations. Richer soils in the basaltic rock areas support diverse woodland soil fauna.

At the coast marine algae and nutrient rich waters enable a variety of marine animals to be successful.

ASSOCIATED TOPICS

T3 The Formation of the Appalachian Region and North Atlantic Ocean, T8 Triassic Basalts and Continental Rifting, T13 Glaciation, T22 Tides, T24 Modifying Forces, T25 Sea Level Change, T31 Soil Development and Soil Climate, T43 Plant Communities in Nova Scotia, T56 Ungulates, T59 Land and Freshwater Invertebrates.

ASSOCIATED HABITATS

H1 to H7 Coastal Habitats, H24 Spruce, Fir, Pine-Maple, Birch Forest, H32 Coastal Forest.

710 Basalt Headlands

Parallel faults and juxtaposed resistant basalts and erodable sandstones create a varied landscape of hills and lowlands, bays, cliffs and headlands. Mineral deposits and fossil remains provide added geological interest. Relict arctic-alpine plants are found on exposed headlands. This region has good deer wintering areas.

GEOLOGY AND GEOMORPHOLOGY

This District extends from Economy to Cape Chignecto along the northern shore of the Minas Basin. The geology and landscape are varied and interesting.

The area has been cut by three major faults into a series of slices which have minor faults within them. At the base of the Cobequids the east-west trending Cobequid Fault forms the northern boundary of the District and sets Carboniferous strata against the ridge of the Cobequid Hills (311). Here they form a line of hills from Cape Spencer to the eastern border of the district and beyond. Cliffs have formed along Greville Bay where these strata reach the coast. Further south the Portapique Mountain Fault (which extends eastwards from Partridge Island) has brought younger erodable Triassic sandstone and resistant basalt into contact with Carboniferous deposits. Within this block another smaller east-west fault, the Gerrish Mountain Fault, and small cross cutting faults further divide the bedrock into small blocks. These have shifted vertically and in some cases have tilted.

From Economy to Partridge Island the hilly landscape reflects the contrasting resistance to erosion of basalt and the Triassic sandstones. The sandstone is very soft and normally forms lowlands. However where it is capped by basalt it forms high steep-sided hills eg. Portapique Mountain, 500 feet (150 m), an unnamed hill north of Lower Economy 600 feet (180 m), Economy Mountain, 800 feet (245 m) and Spencer's Island 500 feet (150 m). The high sandstone cliffs at Five Islands Park and on the islands themselves exist because of the protective effect of basalt. Another prominent headland, Cape Chignecto, is formed from granite and is the most westerly extremity of the Cobequid Hills. Some of the high basalt-capped blocks have cliffs with columnar jointing eg. Partridge Island, Cape Sharp and Spencer's Island. Semiprecious stones are found in the amygdaloidal basalts at Partridge Island.

Exposed Triassic sandstone is easily eroded. At Lower Economy a tidal platform over one mile wide has been cut by wave attack on the coastal exposures of these rocks. The low Triassic area immediately north of Cape d'Or will presumably eventually be removed completely leaving the basalt capped sediments as stacks, similar to Five Islands.

Younger sediments, Jurassic in age, containing dinosaur bones and footprints have been found near the village of Five Islands.

Large glacial outwash deposits are common along the Parrsboro shore. At Advocate the town is built upon an outwash plain. The harbour is enclosed by a bar and cobble beaches derived from gravels eroded from the outwash deposits. In immediate post-glacial time, about 13,000 years ago, a higher sea level created beaches on the hillside north of the present village. These raised beaches are remarkably similar to those in the present Advocate Harbour. At Parrsboro and throughout the district a nearly horizontal wave-cut surface can be seen on the glacial outwash gravels. This surface, eroded at the same time as the Advocate raised beach was being formed, gradually descends eastwards. The sloping nature of the former shoreline is conclusive evidence of differential recovery of the coast since the last glaciation and hence of differential crustal loading during the glaciation.

Streams draining this district tend to be straight and fast flowing, with narrow steep-sided valleys. There are many waterfalls.

SOILS

The principal soils in this area are the Kirkhill and Diligence series. Both are developed on tills from shale of the Riversdale Group. However Diligence shales are softer and produce clay loam soils while Kirkhill shales produce shaley loam soils. Other soils in the area have formed from extensive deposits of gravel laid down as glacial and post glacial outwash plains. These soils are mapped as Hebert gravelly loams.

VEGETATION

The coastal forest is somewhat modified as the climate moves through a transition from maritime to continental. Spruce, Hemlock and pine forests (H.25) with intolerant hardwoods are found here, together with the more common spruce, fir, pine forest (H.23). Pure stands of White Spruce (H.26) are found on oldfields. The exposed cliffs at Cape d'Or provide habitat for arctic-alpine plant species.

Some small salt marshes are found along the shore but there is no Eel Grass. As turbidity of coastal waters diminishes westwards, seaweeds increase, for example Porphyra or laverbread.

FAUNA

The shore provides wintering habitat for deer coming down from the Cobequids. Islands provide breeding areas for Double-crested Cormorants, Common Eider, Great Blue Heron, Herring Gull and Black-backed Gull. At Advocate Harbour tidal flats and salt marshes attract some migratory shorebirds and waterfowl. The shoreline is mostly gravel with considerable silt. The marine fauna is characteristic of rocky, cobbly and muddy shores but with limited diversity due to the silty water. Shells of Slipper limpets, sponges (Chalina) and Hornwrack (Flustra) are commonly found washed ashore.

SITES OF SPECIAL INTEREST

Cape d'Or (IBP Proposed Ecological Site 1)
- wind-swept headland providing arctic-alpine habitat. Notable plants include Oxytropis johannensis and Astragalus robbinsii.

Moose River (IBP Proposed Ecological Site 7)
- mature Red Spruce forest.

Economy Mountain Lookoff
- to north and west steep escarpment of Cobequid fault. Foreground low-lying Carboniferous and Triassic sediments.

Five Island Provincial Park
- dinosaur bones and footprints below park.

Moose Island
- agate and basalt sea stacks.

Partridge Island
- semiprecious minerals.

West Bay
- angular unconformity; fossil rain prints, ripple marks, mud cracks, channel.

Advocate
- raised beaches 115 feet (35 m) above high water; spit across harbour.

Provincial Parks and Park Reserves
- Five Islands

ASSOCIATED TOPICS

T14 Deglaciation and Glacial Deposits, T16 Colonization by Plants, T52 Shorebirds.

ASSOCIATED HABITATS

H1 to H6 Coastal Habitats, H19 Cliff, H25 Spruce, Hemlock, Pine Forest.

720 Basalt Ridge

Basalt lava flows above soft sedimentary rocks form a ridge with a steep south facing escarpment and a shallower north facing dip slope. Cliffs of columnar basalt rise from wide wave-cut platforms along the Fundy shore. Semiprecious mineral deposits occur within the basalt. The coastal forest gives way to hardwoods at higher elevations. Diverse, interesting rocky shore fauna are present on the Fundy coast and relict arctic-alpine flora are found at Cape Split.

GEOLOGY AND GEOMORPHOLOGY

On the southern side of the Bay of Fundy lies a steep sided ridge (cuesta) which rises to over 750 feet (225 m) at its eastern end and slopes to near sea level in the west. The ridge is composed of several basaltic lava flows which dip northwest towards the Bay at a shallow angle. They form the southern rim of a tilted spoon-shaped trough which underlies the Bay of Fundy. The rounded up-tilted eastern side of the trough can be seen in the curve of Scots Bay. The basalt in the lower western part eventually disappears under the water beyond Brier Island (district 810).

The highest elevations and most dramatic scenery are found on North Mountain, particularly at Cape Blomidon where Cape Split sweeps around into the Minas Basin. The steep southern escarpment of the ridge may represent a fault line; the shallower northern side is a dip slope. The section of shore from St. Croix Cove to Cape Split provides a rich ground for mineral collecting since fresh rock is exposed each year after the winter storms.

Windgaps through the ridge are found at Parkers Cove and Delaps Cove. These represent the abandoned lower valleys of rivers which flowed northwards from central Nova Scotia into the present Bay of Fundy and which have been captured by the Annapolis River. Digby Gut is the drowned lower valley of Bear River.

The emergent shoreline is smooth, exposed and rocky with little coastal sediment.

Lava Flows

The number of flows varies along the length of the ridge. Up to seventeen have been counted at Digby Gut but only two can be seen along Digby Neck. The total thickness has been estimated as 1,000 feet (300 m). Between the flows layers of green grit are found. Each of these represents the weathered surface of the underlying flow and is an easier target for erosion than the massive flows; thus the basalt pile appears banded.

Basalt lava flows exhibit a variety of interesting features which reflect their volcanic origins:

Glass: some lava freezes instantly upon contact with the air and forms black glass called Obsidian. This can be found throughout the flows.

Amygdules: gas bubbles trapped in the lava are filled with minerals over time, for example agate, amethyst, jasper, stilbite, heulandite and others.

Erosion

Coastal erosion has cut tidal platforms 350-1,000 feet (100-300 m) wide along the Fundy shore above which rise vertical sea cliffs. The columnar jointing can best be seen along this shoreline.

Overlying the basalt is the Jurassic Scots Bay formation in which fossil fish can be found. These sediments can be found in six small inlets in Scots Bay.

Glaciation

The Basalt Ridge provides evidence that glacial ice moved across it both southwards and northwards at different times. The best evidence of south flow is provided by pebbles of basalt found up to 125 miles (200 km) away along the South Shore. Basalt pebbles are very common in stoney areas of the Annapolis Valley. Evidence of northward movement of glacial ice is provided by occasional boulders of granite, presumably from the South Mountain, which are scattered across the top of the Ridge. These were deposited late in the last glacial period when the South Mountain acted as a local ice centre (district 451). Deposits of glacial gravel are found along the Ridge at

various points. The post-glacial emergence of this area is recorded in the raised beaches which are found at 130 feet (40 m) above present high tide near Digby and at 100 feet (45 m) on Brier Island.

Morphologically the Basalt Ridge owes its prominence not only to the resistant nature of basalt but to the fact that it overlies soft, erodable sediments. The southern side of North Mountain has a steep scarp slope where these softer rocks have been carved out to form the Annapolis Valley. Along Digby Neck these same sediments have been removed to below sea level to form St. Marys Bay. Erosion is actively narrowing the Ridge on the Fundy side although the energy of wave attack is diminished by the presence of wave cut platforms. St. Marys Bay is more sheltered. Streams which flow down the slopes are fast flowing but are also straight and small and have little erosive power.

SOILS

Soils in this District are fairly shallow when developed from the underlying basalt. Rock outcrops occur as ridges parallel to the coast. The main soil derived from basalt is Rossway, a shallow, well drained silt loam. Associated with Rossway is the poorly drained sandy loam, Roxville, found in depressions. On the plateau along the crest of the Ridge Glenmont fine sandy loam appears. It developed from a mixture of red Wolfville till, which originated north of the Ridge, and basalt. Finer textured Wolfville soils, (not drumlinized) occur between Harbourville and Victoria Harbour. There is a large area of Middleton soil (moderately well-drained, sandy clay loam) between Mount Hanley and Arlington West. Small patches of Kingsport and Nictaux soils, developed from water deposited sands and gravels, are also found in this area. Along the Fundy Shore some areas of excessively drained loamy sand (Gulliver series) have formed on wave washed gravels.

The District as a whole is unusual in that earthworms are found in large numbers in the woodlands and their activity has incorporated the surface "mor" into the mineral soil (see T34).

VEGETATION

A much disturbed version of the coastal forest is found at lower elevations in this District.

Tolerant hardwoods occur at higher elevations, where they may be above the level of the cold air from the Bay of Fundy. While Red Spruce is more common here than along the Atlantic Coast, White Spruce is also found throughout, often seeding in abandoned fields. Away from the coasts, the spruce, fir, pine forest with maple and birch (H.24) gradually turns into Sugar Maple, Yellow Birch and beech (H.27) at higher elevations.

Rare arctic-alpine and uncommon Alleghanian plant species are found in the Cape Split/Blomidon area. Seaweed growth, for example *Porphyra* or Laverbread, is extensive at the west end of the District but decreases eastwards as the silt content of coastal waters increases. There is almost no salt marsh along this part of the coast.

FAUNA

The Ridge provides mostly forest habitats with few lakes or wetlands. It supports a high density population of deer, but few bear or bobcat. Small mammal diversity is moderate. The Ridge gives a funnelling effect to the movements of migratory birds, particularly hawks and owls, as they head towards Brier Island in the fall. The funnelling may also hold true for migratory bats which must cross the Bay of Fundy or the Gulf of Maine en route to their wintering area. The exposed basalt along the shore line provides good intertidal habitat with well-marked zonation and large tidepools. Shells of subtidal molluscs and crustaceans are often found near wharves where lobster traps have been emptied. There is some weir fishing.

SITES OF SPECIAL INTEREST

Cape Split (IBP Proposed Ecological Site 65)
- primarily deciduous woodlands with rich herbaceous flora. Rare minerals and semi-precious minerals found in amygdaloidal basalt.

Cape Blomidon
- steep sea cliffs

Cape Blomidon to St. Croix Cove
- good mineral localities

Digby
- raised beach 130 feet, (40 m) above high tide
- Digby Gut, drowned lower valley of Bear River

Point Prim
- wide wave-cut platform

Provincial Parks and Park Reserves
- Valley View
- Cottage Cove
- Blomidon Look-off
- Blomidon
- Scots Bay
- Scots Bay
- Baxter Harbour

ASSOCIATED TOPICS

T47 Rare Plants, T34 Soils, Biological Environment.

ASSOCIATED HABITATS

H1 to H6 Coastal Habitats, H13 Fast-moving Stream, H19 Cliff.

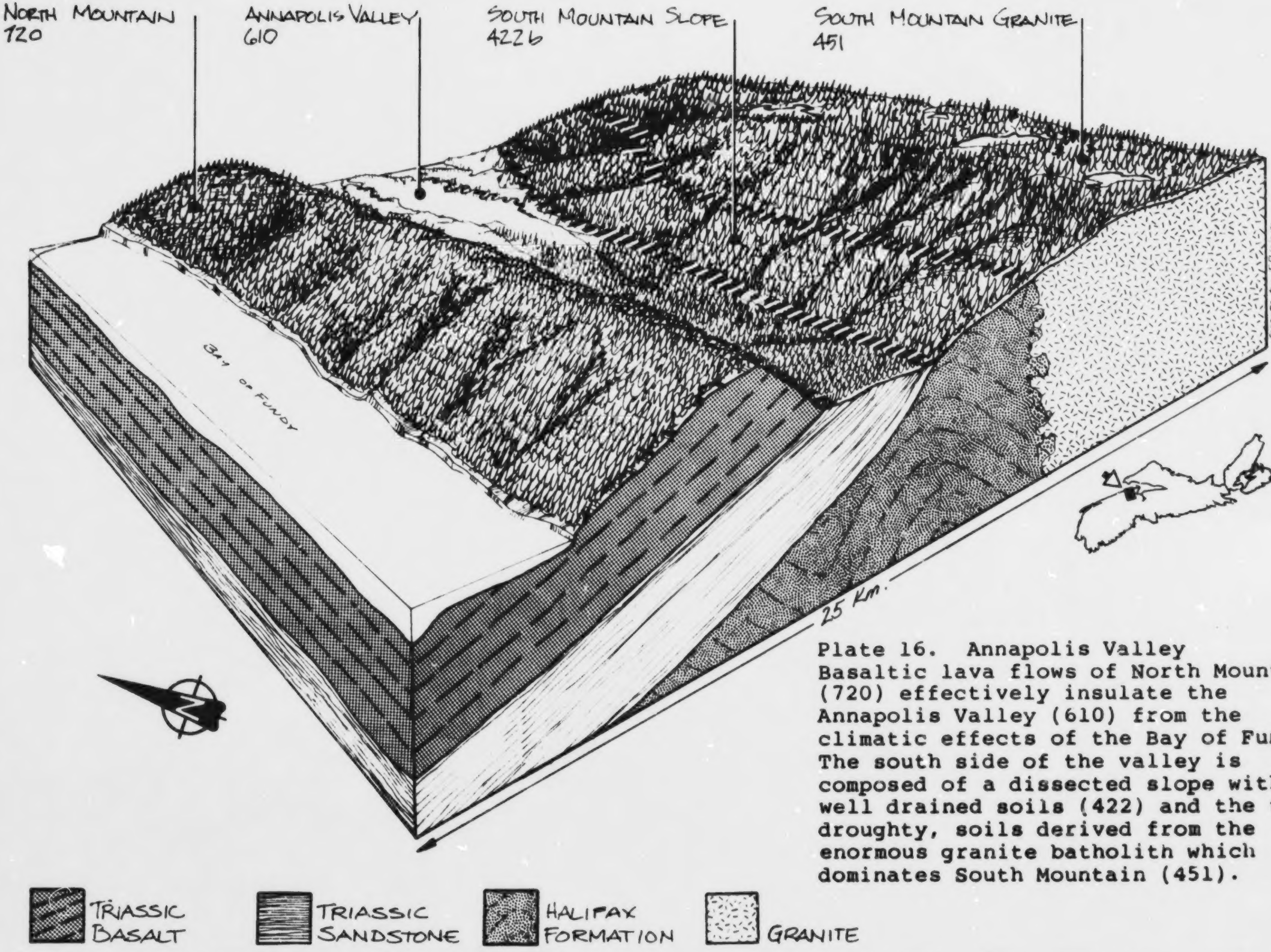
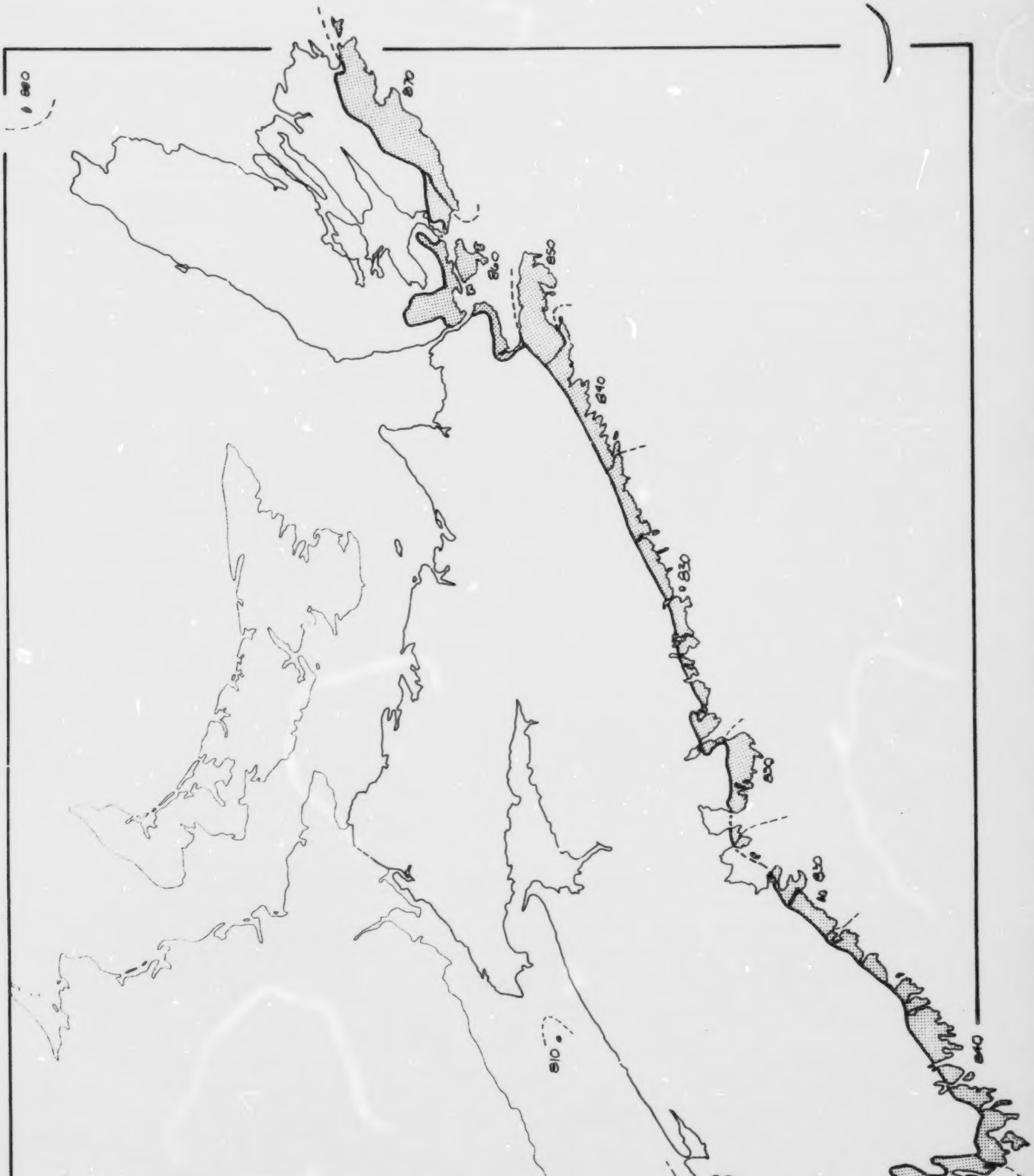

NORTH MOUNTAIN
720
ANNAPOLIS VALLEY
610
SOUTH MOUNTAIN SLOPE
422b
SOUTH MOUNTAIN GRANITE
451
BAY OF FUNDY
25 Km.
N
TRIASSIC BASALT
TRIASSIC SANDSTONE
HALIFAX FORMATION
GRANITE

Plate 16. Annapolis Valley
Basaltic lava flows of North Mountain (720) effectively insulate the Annapolis Valley (610) from the climatic effects of the Bay of Fundy. The south side of the valley is composed of a dissected slope with deep well drained soils (422) and the thin, droughty, soils derived from the enormous granite batholith which dominates South Mountain (451).


880
870
860
850
840
830
820
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810
810

800

800 ATLANTIC COAST

REGIONAL CHARACTERIZATION Exposure to winds from the Atlantic Ocean dominates coastal environments from Digby Neck to Scatarie Island and includes Isle Haute and St. Paul Island. The coastal forest is found throughout and its inland extension marks the regional boundary. Headlands, especially in the granite and quartzite areas are frequently barren. Almost every major rock type in Nova Scotia is found in this region but the soils are often dominated by hardpans due to excessive moisture. Coastal erosion is rapidly reshaping coastal areas with drumlins; there beaches, marshes and waterfowl habitat are found. Seabird nesting colonies and marine mammals are common on coastal islands.

GEOLOGY The Atlantic Coast Region of Nova Scotia cuts across a great variety of rock types

The Western Shore, South Shore and Eastern Shore (districts 820, 830 and 840) are dominated by old, generally very hard rocks of the Meguma Group. They are interfolded slates and greywacke, with local outcrops of metamorphosed volcanic ash and lava (Yarmouth area). Areas of very resistant granite (district 850) also occur. In contrast, Chedabucto Bay has been eroded from weakly metamorphosed Carboniferous sandstones (district 860). Southeastern Cape Breton (district 870) is underlain by metamorphosed Precambrian volcanic ash deposits, sandstone and granite.

At the entrance to the Bay of Fundy, Digby Neck (district 810) is a lowlying basalt ridge (district 850). St. Paul Island (district 880) consists of very ancient Pre-Cambrian rocks similar to those found in the Cape Breton massif.

The coastal bedrock is lowlying and exhibits low relief. Elevations rarely exceed 330 feet (100 m), except on the granite promontories and knolls at Pennant Barrens (unit 851) and Canso Barrens (unit 852) where the maximum elevation is 840 feet (250 m).

GEOMORPHOLOGY

The coastline can be divided into two sections based upon classic features of emergence and submergence. Post glacial readjustment north of a pivot line which lies parallel to the length of the province from Yarmouth to Truro resulted in the immediate post-glacial emergence of Bay of Fundy coasts. From Yarmouth to Scatarie Island the Atlantic coast has been continuously submerged as sea level has risen. The emergent shore has raised beaches, raised wave cut platforms and a smooth shoreline. The submerged shore is highly irregular with drowned estuaries and headlands producing an indented coast fringed by islands. The post-glacial rise in sea level recorded over the past 10,000 years or so has affected all coastal areas. Drowned forests, eroding headlands; salt marshes and beaches being driven inland, are all evidence of the continuing transgression of the sea.

The shape of the coastline is also strongly influenced by the presence of faults, especially along the Eastern Shore and along the southern boundary of Chedabucto Bay. Many of the long inlets in Guysborough County have formed along faults lines. The straight shore west of Cape Canso marks the position of the Chedabucto Fault. The smooth eastern shoreline of the Louisbourg lowlands (and Gabarus Bay) may also be fault controlled. The orientation of St. Marys Bay, North Mountain and Parrsboro Shore also owe much to fault movements within the Bay of Fundy area.

GLACIAL DEPOSITS

The last major flood of ice across Nova Scotia during the Wisconsin Period left a predominantly north - south to northwest - southeast imprint upon the landscape. Pre-existing drainage channels and any faults lying parallel to the flow were deepened. Interfolded strata oriented parallel to the direction of ice flow were differentially eroded leaving ridges and valleys (Tusket area); ridges which were perpendicular to the ice flow were smoothed off. The whole area was then blanketed with glacial till, derived mainly from local sources but also carried from one geological district to another and deposited as drumlins.

Along the coast the quantity of sediment available for redistribution depends in large measure upon the nature of the glacial deposits. Areas with drumlin headlands and islands tend to have adequate sediment supply derived from coastal erosion. Another very limited source of coastal sediment, quartz sand, is washed from the surface of coastal granite bodies which are undergoing subaerial erosion. A more important source of coastal sediment is silt and sand which was carried landwards from glacial deposits on the Scotian Shelf by the sea as it rose during the post-glacial period. Many of the present sand beaches owe their origins to material driven landward in this manner.

COASTAL REGIME Although generally the Atlantic Coast is an exposed, high energy environment, the many indentations along the coast provide sheltered bays and estuaries. The average tidal range is small, at Guysborough Harbour 5.5 feet (1.7 m), at Halifax 4 feet (1.4 m), at Lunenburg 5 feet (1.6 m) and at Barrington Passage 6 feet (1.8 m). In the Gulf of Main however the tidal range increases sharply. At Woods Harbour, 6 miles (10 km) west of Barrington Passage, the average tidal range is 8.5 feet (2.6 m), which becomes 12 feet (3.6 m) at Yarmouth and 16 feet (4.9 m) in St. Mary's Bay. Ocean swells move in from the south and east, though their erosive power is somewhat reduced by northerly off-shore winds, particularly in winter.

Along most of the coast only local pockets of ice can be found in winter, although shore ice forms throughout the Region. Some sea ice may drift westward past the eastern Cape Breton shore. The interactions of the south-flowing Labrador Current and the north-flowing Gulf Stream result in complex movements of contrasting water bodies, and fairly rapid changes in water temperature and salinity. In general the Region is a cool water coast. In summer the coldest temperatures are found around Cape Sable and into the Bay of Fundy, as a result of violent mixing of the surface waters by tidal currents.

CLIMATE

The ocean is the dominant influence on the climate of the Region. The main features are moderated seasonal and daily temperatures, high precipitation and humidity, strong winds, fog, and salt spray.

The winters are comparatively mild, and the summers are short and cool. The mean annual temperature range is 27-36°F (15-20°C), and is least in the southwest, increasing towards Cape Breton. This can be contrasted to a mean annual temperature range of 36-45°F (20-25°C), found throughout the rest of the province. Along the coast spring starts early, but is long and cool. Mean daily temperatures rise above freezing point in about the second week of March in the south, and about two to three weeks later along the Eastern Shore and in Cape Breton. Because of frequent fogs, and the cooling influence of the ocean waters the mean daily temperature in July stays below 59°F (15°C), near the coast, increasing somewhat inland. While mean daily freezing temperatures return to northern inland areas before the end of November, in the Atlantic Coast Region this does not usually happen until after the second week in December, or even as late as the end of December in the southwest. Mean daily January temperatures stay above 24°F (-5°C), and, in some areas, remain above 32°F (0°C).

Like most of the province, the Atlantic Coast receives fairly high total precipitation, generally between 48 and 56 inches (1,200 and 1,400 mm), but between 58 and 64 inches (1,400 and 1,600 mm) in Queens and Lunenburg Counties, and in the northern half of Halifax County. Only about 15 percent falls as snow because of the mild winter temperatures. Most of the Region receives less than 80 inches (200 cm) of snow annually, while Guysborough County and Cape Breton receive less than 60 inches (150 cm). The snow cover season starts late and finishes early, ranging from less than 100 days near Cape Sable to over 130 days in Cape Breton. Snow accumulations are usually low.

Fog and high humidities are common along the Atlantic coast. Summer and fall are the main seasons for fog, when warm, moist air moving in from the south comes into contact with the cool

Atlantic coastal waters. On average, fog occurs 15 to 25 percent of the year. The southwest section of the coast is the foggiest, with Yarmouth registering an average of 120 days on which fog occurs.

The main features of the bioclimate of the Atlantic Coastal Forest are the long frost-free period, the long growing period, combined with cool summer temperatures, low evapotranspiration rates, and exposure to wind.

SOILS

The important factor influencing soil development in this Region are the high precipitation and shorter winters, resulting in strong leaching action over a greater part of the year; the resistant igneous or metamorphic bedrock; low relief; and the slow decomposition of leaf and needle litter. In general the soils are shallow, coarse, Podzols, usually sandy loams, acidic and strongly leached; alternating with areas of exposed bedrock and organic deposits. Gleyed Podzols and Gleysols are also common, particularly in southwestern Nova Scotia. Small areas of coarse soils developed on glacial outwash sands and gravels are found throughout the Region. Mixtures of finer textured Carboniferous material show up in drumlin areas. In eastern Cape Breton heavy clays can be found on deeper, flat, poorly drained tills. All along the Atlantic coast extensive pan formations (ortstein) are common which severely impede soil drainage, causing layers of thick surface humus to accumulate.

VEGETATION

The Atlantic Coastal Forest Region lies within and is defined by, Louck's Spruce-Fir Coast Zone. The major influences on the regional vegetation are the marine climate and extensive disturbance through fire and cutting. The cool, wet, acid conditions favour conifers. Hardwoods are usually restricted to higher, better drained sites, which are sheltered from coastal wind exposure. On headlands and exposed ridges trees are usually severely stunted. Continuous high winds increase transpiration, and trees may actually become "desiccated" in spite of high rainfall. Salt spray can kill part or all of a tree, but its effects are limited to a fairly narrow band along the coast. White spruce, which has high tolerance to the adverse effects of wind and salt spray, is the characteristic species found closest to the sea.

In the southwestern part of the Region White Spruce, Black Spruce and Balsam Fir are accompanied by White Birch and Red Maple (H.32). The re-appearance, inland, of White Pine and Red Oak usually indicates less rigorous climatic conditions and can therefore mark an approximate inland boundary. In the northern part of the Region, where the winters are colder, White Spruce continues to be prominent along the shore, but is less abundant away from the water. Dense stands of Balsam Fir, Black Spruce and White Spruce are characteristic, along with the virtual absence of Red Spruce, White Pine, and most hardwood species. Jack Pine sometimes occurs on fire barrens, and Larch is common on wetter soils, particularly in Cape Breton. Another factor limiting tree growth in this part of the Region, beside wind exposure may be excessive density. Throughout the region barrens or semi-barrens are common, supporting mostly low, ericaceous (heath) vegetation. Sphagnum bogs are also common in depressions.

C.D. Howe's description of this "inferior" or "black" forest made in 1912 is still true today. "The numerous peninsulas formed by the long re-entrant bays and harbours are covered with an inferior black spruce-fir forest, and exhibit abundant bogs. The softer places in the rock have been worn into little hollows and pockets, sometimes only a few feet and usually not many rods apart. These fill with water which cannot drain away freely because of the massive quartzite beneath. The loss by evaporation is replaced by frequent rains, but it is also very much retarded by the natural humidity of the air. The result is a sour soil composed of raw humus, and hence the stunted forest. The trees are about ten to fifteen feet high, and frequently, not more than three or four feet high in the more boggy situations. A section of one of these trees, three-eights of an inch in diameter, when placed under a compound microscope revealed 47 annual rings. On the drier portions where a little real soil is present, one finds sapling thickets and dense polewood stands of fir. Along the streams of normal rapidity the stand is mostly second growth yellow birch and red maple."

FAUNA

The terrestrial habitat mix provided by the Atlantic Coast Region consists mainly of forest (mostly conifers) barrens and bogs. The main faunistic interest is provided by the extensive range of coastal and marine habitats, including rocky shores, sandy beaches, dune systems, mud flats, salt marshes and islands. These habitats provide breeding and feeding areas for a wide range of resident and migratory birds.

The coastal strip from Halifax around to Meteghan and inland for 6-12 miles (10-20 km) has the least persistent winter snow cover of any area in the province. This creates severe microclimatic stress for small mammals during cold snaps and in the case of the Deer Mouse this stress is at the limits of tolerance for that species. It is almost certainly because of this that Deer Mice are very rare there and are usually absent from most areas in the zone at most times. The White-Footed Mice are the dominant species of Peromyscus in the Unit.

The marine fauna is mostly cold water boreal in character but is not homogenous all along the coast. Sheltered inlets and pockets of warmer water support many species with a more southerly distribution. Productivity is high along the edge of the Scotian Shelf and marine mammals are quite numerous. The Atlantic coast is often visited by unusual bird and marine species, carried by winds and currents from other parts of the Atlantic Ocean.

The Atlantic Coast Region is divided into eight districts based upon their major geomorphological characteristics:

810	Basalt Peninsula
820	Cliffs and Beaches
830	Beaches and Islands
840	Quartzite Headlands
850	Granite Barrens
860	Sedimentary Lowland
870	Till Plain
880	Cliffed Island

Districts 830, 840 and 850 are further divided into units based upon geomorphological, soil and vegetation characteristics.

ASSOCIATED TOPICS

T11 Development of the Ancient Landscape, T12 Tertiary Drainage Patterns, T13 Glaciation, T14 Deglaciation and Glacial Deposits, T15 Post-glacial Climatic Change, T21 Ocean Currents, T22 Tides, T23 Oceanic Environments, T24 Modifying Forces, T25 Sea Level Change, T26 Coastal Landforms, T27 Shoreline Types, T28 Offshore Bottom Characteristics, T31 Soil Development and Soil Climate, T43 Plant Communities in Nova Scotia, T51 Wetland Birds and Waterfowl, T52 Shorebirds, T53 Seabirds, T61 Marine Fishes, T62 Marine Mammals, T63 Marine Invertebrates.

ASSOCIATED HABITATS

H1 Benthic, H2 Open Water, H3 Rocky Shore, H4 Boulder Cobbleshore, H5 Sandy Shore, H7 Salt Marsh, H8 Coastal Fresh Marsh, H9 Dune System, H17 Barren, H19 Cliffs, H32 White spruce, Fir-Maple, Birch (Coastal) Forest.

810 Basalt Peninsula

CHARACTERIZATION

A westerly extension of the North Mountain basalt ridge forms a double ridge with an intervening drainage catchment. Isle Haute is also part of this district. Topographic elevations decline westwards. The ridge is cut by parallel faults. Brier Island is an important staging area for birds and has rare plants. Offshore upwelling creates a rich plankton with abundant seabirds and whales.

GEOLOGY AND GEOMORPHOLOGY

Digby Neck is formed from two thick lava flows with an intervening erodable layer. The flows dip to the northwest forming twin ridges with a central valley along the spine. The elevation of the Neck decreases westwards reaching sea level at Brier Island and continuing as rock ledges beyond.

The Neck is cut by four parallel faults. Two of these have been eroded to below sea level and form the Passages at the northern ends of Long Island and Brier Island. The other two have not been flooded and are manifest as coves and valleys crossing the Neck at Mink Cove and Gulliver Cove. Sandy Cove is a wind gap probably cut by an ancient predecessor of the Sissiboo River which flowed northwards before being 'captured' by a river which flowed westwards in what is now St. Marys Bay.

The main drainage is along the central depression of Digby Neck where long streams interconnect occasional lakes and ponds.

SOILS

The soils of Digby Neck are similar to those on the rest of North Mountain (district 720). Rossway, a well drained sandy loam, covers much of the area. Its imperfectly drained associate Roxville occurs in the central depression. Poorly drained Tiddville soils develop where organic material accumulates. Brier Island has large areas of peat. In the coves coarse Medway soils have developed from stratified quartzite or schist gravel.

VEGETATION

Digby Neck differs from the Fundy coast (region 700) in that it is more exposed to marine influence, particularly storms moving in from the south and east. Therefore the coastal spruce-fir forest (H.32) is dominant and hardwoods are not found in pure stands. A series of bogs are found along the central depression. The sedge and sphagnum bogs on Brier Island contain rare and unusual plants such as Geum peckii, Betula michauxii, and Curly Grass Fern. The Brier Island orchid flora is also important.

The rocky shores and low silt content of coastal waters provide good substrate for seaweed, including well developed Laminaria beds, and the economically important seaweeds Dulse and Irish Moss.

FAUNA

This District is of great faunistic interest for two main reasons - Brier Island's position as the final westward staging point for migratory birds, insects and bats, and an area of upwelling and high productivity which occurs just off the coast. In the summer and fall large flocks of Phalaropes gather off Brier Island prior to migration. In spring Atlantic Brant and Black Duck are frequently seen. In summer a wide variety of shorebirds collect. By the fall their numbers will have diminished somewhat. Over the winter Common Goldeneye and sea ducks will be present but not abundant. Purple sandpipers winter along the rocky shores of the entire coast. Common and Arctic Terns breed on Peters Island between Brier Island and Long Island, and this area also shelters moderate numbers of Black Duck and Common Eider in winter.

The upwelling off the coast makes Brier Island an important area for observing migratory whales.

Rocky shores show good zonation and have large tidepools, providing diverse fauna. The common periwinkles grow to the largest size of any place in Nova Scotia. Subtidal molluscs may be found on the shore as a result of emptying of lobster traps. Weir fishing is carried out, largely for Herring.

SITES OF SPECIAL INTEREST

Brier Island (IBP Proposed Ecological Site 59)
- two bogs with relict and rare plants, stop-over area for migrating birds and wintering area for Common Eider.

Ventral Bog (IBP Proposed Ecological Site 60)
- sphagnum bog with circum-neutral humus layer, presence of disjunct plants, especially skunk cabbage, and possible refugia for coastal plain flora.

Midway Lake
- residual aquatic fauna.

Sandy Cove
- glacial gravels and kettle holes

Brier Island
- columnar basalt on south side
- raised beach 150 feet (45 m) above high tide

East Ferry
- columnar basalt south of ferry lands

Provincial Parks and Park Reserves
- Central Grove
- Lake Midway

ASSOCIATED TOPICS

T8 The Triassic Basalts and Continental Rifting, T36 Algae, T47 Rare Plants, T48 Factors Influencing Avifauna.

ASSOCIATED HABITATS

H1 to H5 Coastal Habitat, H14 Blanket and Raised Bog, H32 Coastal Forest.

820 Cliffs and Beaches

This smooth, coastline with raised beaches and wave cut platforms, which emerged in the early post-glacial period, is now being submerged. It has many examples of subglacial and glaciofluvial deposits. The cliffed coast has sheltered muddy areas with some salt marshes, sandy beaches, dune systems and submerged forests. Coastal waters provide important wintering grounds for the Common Eider.

GEOLOGY AND GEOMORPHOLOGY

This District encompasses a strip of coastline along the eastern shore of St. Marys Bay. The bedrock consists of metamorphosed, interfolded slates and greywacke of the Meguma Group which are highly eroded and have little relief. Overlying the bedrock is a ground moraine of varying thickness on which are superimposed good examples of subglacial and glaciofluvial deposits such as end moraines, deltas and spits. Evidence of coastal rebound and tilting following glacial withdrawal, is found in raised beaches and wave cut platforms. The effects of the more recent coastal submergence are seen in beach erosion, retreating till cliffs, and submerged forests along the shore.

Detailed analysis and description of the surficial geology is found in the work of D. Grant (Geological Survey of Canada) completed during the 1970s.

SOILS

The soils in the northern part of this District derive from moderately coarse-textured quartzite till and are predominantly imperfectly drained Danesville with poorly drained Aspotogan. South of Meteghan the tills are somewhat finer in texture and derived from slate. The three associated soils are well drained Bridgewater, imperfectly drained Riverport and poorly drained Middlewood. In Yarmouth County the soils are developed on drumlinoid mounds of till derived from schistose rocks. On the drumlins the soils are moderately well drained sandy loams of the Yarmouth series, often cleared and farmed.

Between the drumlins Deerfield soils are prevalent. Drainage is restricted by a compact, nearly impervious parent material and seepage spots are common. Areas of peat, Bridgewater, Mersey and Halifax soils also occur. All along the coast Digby soils can be found on the raised beaches. These are rapidly drained sandy loams over a gravelly till containing many shells of marine origin.

VEGETATION

The vegetation of this District has been extensively disturbed by cutting. Poor drainage conditions over much of the area have given rise to large numbers of peat bogs. White Spruce and Balsam Fir are the most common species, together with intolerant hardwoods. On the wetter areas Black Spruce and Larch are found. In this area Calamagrostis meadows are quite common. Along the more sheltered, muddy coast small salt marshes have developed, and, unlike the Bay of Fundy, Eel Grass beds can be seen.

FAUNA

This section of the coast has a mixture of intertidal muds, sandy beaches with some dunes, and rocky shores, with some salt marshes. The south shore of the Bay is considered regionally important because large numbers of Common Eider overwinter there. Waterfowl are also present in moderate numbers in early spring and fall, but not in summer. The salt marsh and mud flats at Cape Cove also provide attractive habitat for Black Duck and shorebirds, although their numbers are not large. Because of the ample sediment marine infauna is richer than the epifauna. Unusual offshore species are often washed up on the sandy beaches, which offer good shell collecting. In the warm, sheltered waters towards the head of the bay residual marine fauna may be found, for example Quahog Shells and marsh snails (Ovatella) at Gilbert Cove.

SITES OF SPECIAL INTEREST

A. Glaciation and Post-glacial Emergence, (north to south)

Bingay's Brook (northeast of Barton)
- oysters in interglacial deposits, show that high sea levels occurred between advances of glacial ice.

Church Brook (northeast of Gilbert Cove)
- glaciomarine delta 70 feet (22 m) above high tide, now a gravel pit

Belliveau Cove to Metaghan River
- end moraine complex forms prominent ridge fronting the coast for 12 miles (20 km) (best developed at Saulnierville)

Meteghan
- glaciomarine delta upraised 65 feet (20 m) above high tide

Picnic park to south of Pointe à Tom
- perfect fossil wave-cut platform forms a beach at 15 feet (5 m), also a modern equivalent

Mavillette
- large fossil spit exploited for gravel

Cape Cove (south of Cape St. Mary)
- complete sequence of glacial tills from last 120,000 years, see T24.

Green Cove (north of Port Maitland)
- marine terrace under the campground

Red Head (south of Port Maitland)
- raised and tilted wave-cut platform with a modern example. This area provides the most southerly evidence of post glacial coastal tilting and emergence. The pivot point for coastal rebound and tilting lies close to Yarmouth.

B. Recent Submergence, (north to south)

West of Church Point
- a submerged forest, 15 feet (5 m) below high tide, dated as 5000 years old

Pointe des Marechal
- submerged forest, 10 feet (3 m) below high tide

South of Overton
- submerged forest, 3 feet (1 m) below high tide

Yarmouth Bar
- eroding tombolo

Cape Saint Mary (IBP Proposed Ecological Site 55)
- salt marsh and sand dune system of over 300 acres (120 hectares)

Grosses Coques (IBP Proposed Ecological Site 58)
- salt marsh system

Provincial Parks and Park Reserves
- Savary
- Smuggler Cove
- Mavillette Beach
- Port Maitland Beach
- Bluff Head
- Pembroke
- Sand Beach
- Cape Fourchu
- Kelly's Cove

ASSOCIATED TOPICS

T4 Avalon and Meguma Zones, T24-28 The Coastline.

ASSOCIATED HABITATS

H1 to H7 Coastal Habitats, H19 Cliff, H32 Coastal Forest.

830 Beaches and Islands

GEOLOGY AND GEOMORPHOLOGY

This District is found on the exposed southeast facing coast of Nova Scotia. It is generally underlain by slate bedrock but also includes outcrops of greywacke/quartzite and granite. The slate and greywacke bands are interfolded and the fold axes are either perpendicular to (Tusket), or more commonly parallel to the coast. Differential erosion of softer slate and harder greywacke has created a ridge and valley topography which in places is quite distinctive. The best example occurs where the glacial north-south scouring was in a direction parallel to the fold axes (Tusket).

The shoreline is submergent and exhibits characteristic features such as drowned headlands and estauries; it is irregular and very indented.

Sediment Sources

The major sediment sources are:

1. Offshore deposits
   - sand carried landward during the post-glacial marine transgression over glacial deposits on the Scotian Shelf. The volume of sand reflects the nature of these deposits ie. whether they were unsorted till (less sand) or sorted glaciofluvial deposits (more sand).
2. Eroding headlands
   - thick till deposits forming cliffs on exposed shores.
3. Drumlin islands
   - clay, sand and cobblestone material dumped offshore and directly exposed to wave attack.
4. Glaciofluvial deposits
   - sands and gravels in river valleys now being redistributed by fluvial action.
5. Quartz from granite
   - white sand only locally of any significance.

Deposition

The pattern of deposition depends upon the size distribution of the material, the morphology of the coastline, and the exposure to and direction of wave attack. Coarse material is found in exposed localities around headlands, where the proportion of sand is small, and where an oblique wave front carries fine material along the shore. Sand is found in sheltered coves and inlets, on the lee side of headlands and islands and where a change in direction of the coastline provides a sink for sediment transported along the shore. Depending upon the location, sediments form bay and barrier beaches, spits, bars, salt marshes and dune systems.

FAUNA

The indented coastlines and abundant sediment supply result in a wide diversity of coastal habitats in this District, including rocky shores, sand and cobble beaches, mud flats and salt marshes. These in turn result in the presence of a large variety, and sometimes large numbers, of waterfowl and shorebirds; they shelter in the inlets and estuaries, and feed on the mud flats and salt marshes.

District 830 is divided into four Units based upon coastal morphology, soils and vegetation.

831	Tusket Islands
832	LaHave Drumlins
833	Eastern Shore Beaches
834	Bay of Islands

ASSOCIATED TOPICS

T4 Avalon and Meguma Zone, T24-28 The Coastline.

ASSOCIATED HABITATS

H1 to H7 Coastal Habitats, H9 Dune System, H32 Coastal Forest.

UNIT 831: TUSKET ISLANDS

A submerged coastline with long promontories and inlets. The abundant sediment supply gives extensive salt marsh development. Mild winter conditions permit survival of relict coastal plain flora species. Relatively ice-free conditions provide important wintering habitat for waterfowl. Upwelling and tidal mixing create nutrient rich waters supporting a diverse marine fauna.

GEOLOGY AND GEOMORPHOLOGY

In this part of southwestern Nova Scotia the geological structures intersect the coastline more or less at right angles. As the glacial ice flowed north-south, more or less parallel to these structures, it exploited weaker bands and left a series of long parallel ridges and valleys. These have become progressively submerged as sea level has risen during the last 12,000 years creating a highly indented coastline with many elongated islands oriented north-south.

Drumlins occur both onshore and as offshore islands. Examples of glaciofluvial deposits are also common, especially eskers. The glacial deposits provide an ample sediment supply.

SOILS

The dominant feature of this Unit is the extensive areas of salt marsh. These are a uniform silt loam in texture and occupy more than 8,000 acres. Upland soils in general have developed from schistose slate or quartzite on drumlinoid land forms, although the central strip from Dunn Lake to Comeau Hill is an exception, being relatively flat with shallow soils. Better drained soils are Yarmouth and Mersey derived from schist and quartzite, and Medway soils from outwash sands and gravels. Imperfectly or poorly drained soils, which are often mottled, indicating saturation for considerable periods of time, include Deerfield, Riverport, Liverpool, Danesville, Aspotogan and Pitman. Large peat areas have developed near Pubnico Harbour. The islands are nearly all either Mersey (drumlins) or Liverpool soils.

VEGETATION

Areas of Yarmouth, Deerfield, Medway and Mersey soils are often cleared for agriculture. Otherwise they normally support good growth of White Spruce and Balsam Fir, with Red Maple, birch and poplar. Better drained, more sheltered sites may have some pine or oak. Black Spruce and Larch swamps are common. Because of the fairly high rate of erosion the transition from salt marsh to spruce woods is often quite abrupt. A fringe of grey, dead trees is usually found at the rear of the salt marshes, as the rising sea level drowns their root systems. The Southwestern Flora is well represented in this Unit, particularly along river and lake margins and in bogs. Examples include a bladderwort (Utricularia subulata) and Curly Grass Fern.

FAUNA

The mild temperatures in winter, the many islands and sheltered inlets, and the extensive areas of salt marsh and inter-tidal sands and muds, produce a very important wintering area for waterfowl, and for certain other species such as Bald Eagles. Present in the greatest numbers are the Black Duck, Canada Goose, scaups and the Common Goldeneye. Less common birds include the Red-breasted Merganser and Oldsquaw. Shorebirds begin to arrive in small numbers in the spring, with a peak in early to mid-August and a sharp decline in numbers in September. Osprey breed along this shore and Leach's Storm Petrel breeds on the Tusket Islands.

A rich marine fauna is associated with this unit. The warmer inshore waters support a number of invertebrate species with a more southerly distribution. An area of upwelling offshore, combined with tidal mixing, provides nutrient rich waters which support abundant algae, crustaceans and open sea fish. The Tusket supports a large run of Gaspereaux in the spring.

The more fertile soils derived from schists result in more productive inland waters and a fairly diverse freshwater fauna, particularly molluscs. The fauna also includes a southwestern element, the best known example being the Acadian Whitefish.

SITES OF SPECIAL INTEREST

Spinney's Heath (IBP Proposed Ecological Site 52)
- large, undisturbed bog near Central Argyle.

Chebogue Lake (IBP Proposed Ecological Site 53)
- large inland salt lake with rich beds of eel grass, also known as Melbourne Lake, is a provincial sanctuary for waterfowl.

Moses Lake (IBP Proposed Ecological Site 51)
- Old growth deciduous forest.

Road from Arcadia to Pinkney Point follows an esker.

Provincial Parks and Park Reserves
- Glenwood
- Upper West Pubnico

ASSOCIATED TOPICS

T16 Colonization by Plants, T59 Land and Freshwater Invertebrates, T60 Freshwater Fishes.

ASSOCIATED HABITATS

H7 Saltmarsh, H15 Blanket and Raised Bog, H32 Coastal Forest.

UNIT 832: LAHAVE DRUMLINS

Swarms of drumlins on land; shoals and islands offshore, dominate this Unit. Slate forms promontories and bedrock islands. An ample sediment supply and varied coastline provide a rich diversity of coastal habitats, supporting a mixture of southern and northern fauna, and significant numbers of waterfowl and seabirds.

GEOLOGY AND GEOMORPHOLOGY

Between Voglers Cove (at the mouth of Voglers Brook) and Aspotogan, the South Shore of Nova Scotia is characterized by the presence of many drumlins with a predominantly northwest-southeast alignment. They occur both inland where they are cleared and farmed, and offshore where they form wooded islands with rounded profiles. In the southern part of the area promontories and islands of slate bedrock are also found.

The drumlins are the coastal and offshore equivalents of the Kejimkujik Drumlins (unit 433) and the Lunenburg Drumlins (unit 434). The former are composed of grey/brown clay till derived from local slate, and the latter of red/brown sandy till from the Carboniferous and Triassic deposits over 60 miles (100 km) to the north. The slate till drumlins characteristically are not found far beyond the slate belts. The red Lunenburg Drumlins commonly form islands especially north and east of Cape LaHave.

The variable quantity and texture of the coastal sediment supply has built up a range of shoreline deposits which vary from extensive sandy beaches to small shale beaches to cobble beaches. Most of the sediment appears to be of local origin and comes from the glacial tills. Crescent Beach is a sand bar connecting some of the Cape LaHave islands to the mainland.

SOILS

There are two main types of drumlin soil parent material. To the west of the LaHave River drumlins are derived from slate on which shaley loam soils of the Bridgewater series have developed. Soils between the drumlins are of the same material, but are shallow and often poorly drained. To the east the drumlin materials are finer textured, reddish, sandy clay loams. These Wolfville soils are similar to those found throughout District 430, east of the LaHave River. It is possible that they originated in New Brunswick. Most of the islands have Wolfville soils, the main exception being Cape LaHave Island which is mostly rockland.

VEGETATION

White Spruce and Balsam Fir are the dominant species along the coast, with some maple and birch intermixed in more sheltered locations. Pure stands of White Spruce are found on some drumlins and on old fields. Further inland spruce, fir and pine forest occurs. Salt marsh and Eel Grass beds are common.

FAUNA

This Unit provides a diversity of coastal habitats - rocky shores, cobble beaches, extensive sand beaches, tidal flats and salt marshes. The area around Cape La Have Island to Rose Bay and the western shore of Mahone Bay at Blue Rocks are locally important as waterfowl and shorebird habitat. In spring, fall, and early winter waterfowl numbers are low. Black Duck, Common Goldeneye and Oldsquaw may occur, and Scoter are sometimes present in significant numbers. The Red-necked Grebe over-winters in this area. From early August through September shorebirds congregate at Crescent Beach and Cherry Hill Beach in moderate numbers. Piping Plovers breed at Cherry Hill Beach and Kingsburg Beach. Pearl Island (a provincial Wildlife Management Area) is regionally important because it provides breeding habitat for the Common Puffin, Leach's Storm Petrel, Razorbill and Black Guillemot. Gulls, cormorants, terns and the Great Blue Heron breed on other islands along the coast.

Sheltered inlets support a southern mix of marine fauna, while exposed rocky shores support a more northern fauna. The major rivers provide distinct estuarine conditions for brackish water species. Periodic slope water incursions bring in warm water species such as seahorse, blue crabs and sharks.

SITES OF SPECIAL INTEREST

Blue Rocks
- blue-grey slates and sandstones of the Halifax formation.

The Ovens Natural Park
- gold mined from steeply inclined sandstones and slate strata. Sea caves have developed through erosion of the softer layers.

Kingsburg
- Coastal exposures of Goldenville formation sandstones and siltstones; Piping Plovers.

Pearl Island
- Provincial Wildlife Management Area

Provincial Parks and Park Reserves
- Risser's Beach
- Bush Island
- Feltzen South
- Upper Blandford
- Bayswater Beach

ASSOCIATED TOPICS

T13 Glaciation, T50 Birds of Prey.

ASSOCIATED HABITATS

H1 to H5 Coastal Habitats, H7 Salt Marsh, H32 Coastal Forest.

UNIT 833: EASTERN SHORE BEACHES

An indented drowned coastline with headlands, long inlets and drumlin islands. Active reworking of ample coastal sediment is building spits and barrier beaches between headlands and islands. The inlets provide migration and overwintering habitat for waterfowl.

GEOLOGY AND GEOMORPHOLOGY	This Unit extends from Halifax to Owls Head near Clam Harbour along an indented submergent coastline. The bedrock is dominated by greywacke, with bands of slate, folded parallel to the coastline. The coast is divided into headlands separated by long inlets. Most inlets are drowned river estuaries and do not appear to be fault controlled. Porters Lake, which stretches inland from Terminal Beach, is the exception in this regard, as it occupies a fault zone. Loose cobbly quartzite till forms the ground moraine and is overlain in two areas by drumlins composed of red-brown Lawrencetown tills. The drumlins are concentrated in the Chezzetcook to Lawrencetown and Clam Bay areas. They rarely form islands but are more usually seen as eroding coastal buffs, such as Hartlen Point. Three of the islands within Chezzetcook Inlet are drumlins. The irregularity characteristic of a youthful submergent coastline is being smoothed off here as sediment is redistributed. Sand and gravel are supplied from the erosion of deep glacial tills and glacial outwash deposits along the coast. Spits and barrier beaches connecting promontories and islands protect the large, shallow estuaries from ocean waves, allowing salt marshes to develop.
SOILS	Well drained Halifax gravelly sandy loams derived from quartzite cover much of this Unit. On areas with less relief imperfectly drained Danesville soil is common with peat, rockland, and some small areas of poorly drained, mottled Aspotogan soil. Some areas of shaley loam Bridgewater soil have developed from parent materials derived from slate. Finer textured Hantsport soils (imperfectly

drained sandy clay loam) are found around Eastern Passage, which have developed from Carboniferous parent materials. Wolfville drumlin soils are common, especially in Cole Harbour, Three Fathom Harbour and Clam Harbour. The Halifax peninsula, which is underlain by slate except in the extreme north end, has mostly Bridgewater soils.

VEGETATION

The coastal White Spruce, Balsam Fir forest with maple and birch predominates. On old farm lands and drumlins pure stands of White Spruce are common. Further back from the coast, spruce, fir and pine stands occur. Salt marsh and sand dune plant communities, and large beds of Eel Grass are common.

FAUNA

The mix of coastal habitats is similar to that found in Unit 832 (LaHave Drumlins) where sheltered inlets favour a more southerly marine fauna, while exposed rocky shores support more northerly species. Periodic incursions of warmer slope water bring in warm water fish and invertebrates in the summer. Recently marine algae have been reduced by large populations of sea urchins, but these populations appear to have collapsed and a rapid seaweed recovery is underway.

Cole Harbour, Chezzetcook Inlet, Petpeswick Inlet and Musquodoboit Harbour are important areas providing migration and winter habitat for significant numbers of waterfowl. In spring, particularly mid-March to mid-April, these areas are a stop-over for several thousand Black Duck and Canada Geese. The numbers peak again in October. There is also significant Black Duck breeding in coastal barrier beach, estuary and coastal marsh habitat. In terms of numbers this is the most important area for Black Ducks and Canada Geese in the province. Other overwintering birds are the Common Goldeneye, which occurs in moderate numbers and an occasional Scaup. Great Blue Heron and Osprey nest on McNabs Island and elsewhere. Piping Plovers nest at Lawrencetown and Clam Bay. This coast also provides feeding and some scattered nesting habitat for Bald Eagles.

SITES OF SPECIAL INTEREST

Hartlen Point
Cole Harbour
Conrads Beach (IBP Proposed Ecological Site 36)
- Barrier sand dunes

West Lawrencetown Marsh
Three Fathom Harbour
Chezzetcook Inlet
Petpeswick Inlet
Martinique Game Sanctuary
Provincial Parks and Park Reserves
- South East Passage
- McCormack's Beach
- Cow Bay
- Cole Harbour
- Porter's Lake
- East Chezzetcook
- Martinique Beach
- Clam Harbour Beach

ASSOCIATED TOPICS

T51 Birds of Prey.

ASSOCIATED HABITATS

H7 Salt Marsh, H10 Dune System.

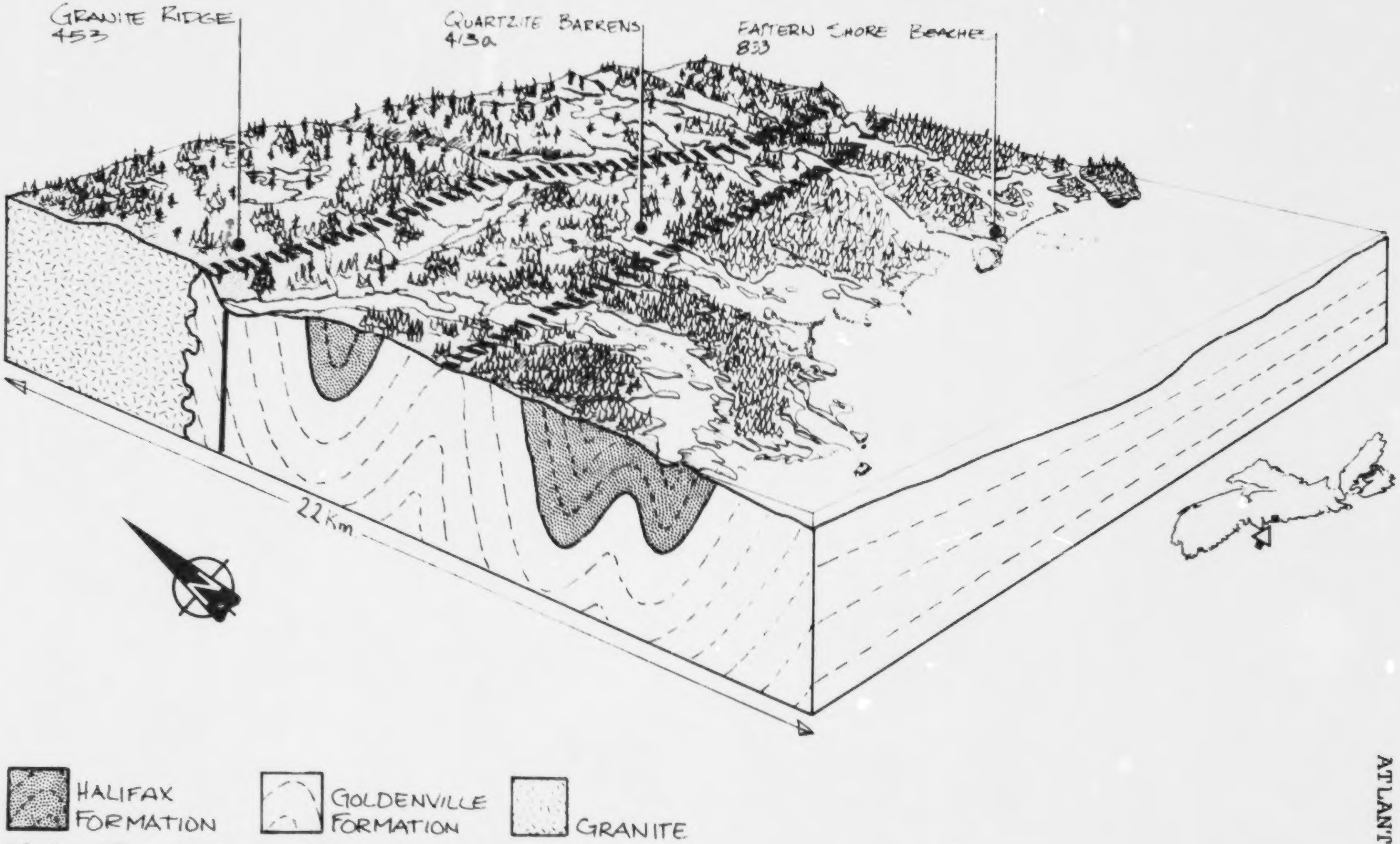

GRANITE RIDGE
453
QUARTZITE BARRENS
413a
EASTERN SHORE BEACHES
833
22 Km
HALIFAX FORMATION
GOLDENVILLE FORMATION
GRANITE

Plate 17. Eastern Shore Beaches
The severe environment created by the Meguma Group rocks is tempered by the presence of drumlins betwen Cow Bay and Clam Bay. Long, drowned estuaries, salt marshes and sand beaches are found in this coastal forest region (833). Inland the Quartzite Barrens (413) give way to a significantly higher granite upland (453) on which are found many lakes.

UNIT 834: BAY OF ISLANDS

Submerged rocky coastline with parallel geological structure gives a series of elongated offshore islands. Variable sediment accumulation produces a variety of coastal habitats from rocky shore with extensive seaweed growth, to salt marsh. The islands provide important breeding habitat for seabirds.

GEOLOGY AND GEOMORPHOLOGY

This Unit extends from the headlands of Little Harbour (southwest of Ship Harbour) to Liscomb Harbour and north to the head of major inlets. The axes of folds within the greywacke bedrock are parallel to the coastline forming a ridge and valley topography. This orientation is reflected in the shape and alignment of the offshore islands which have been formed as the low, eroded headlands were drowned during recent coastal submergence. The islands tend to be elongated east-west and have average elevations of less than 50 feet (15 m). They are divided into groups by bays and inlets. Drumlins, which occur in scattered groups forming headlands all along the Eastern Shore, are rarely found as islands in this area.

Sedimentary structures illustrating how the Meguma bedrock has been built up from the accumulation of gravity slide deposits are found at Taylors Head.

SOILS

On the flatter areas close to the coast around Ecum Secum, Moose Hill, Quoddy and Sheet Harbour, imperfectly drained Danesville sandy loams have developed from the underlying quartzite. Drainage is impeded by bedrock and topography. Elsewhere the soils are mostly rapidly drained Halifax sandy loams with poorly drained Aspotogan and peat areas. Some Wolfville drumlins (sandy clay loam) are found around Quoddy, Beaver Harbour, Popes Harbour and Ship Harbour. Coarse, rapidly drained Hebert soils are found near Moser River. The islands are usually either rockland or have a thin covering of Halifax soils, but a few have Wolfville or Danesville soils. Ironpans are common throughout this Unit.

VEGETATION

The coastal White Spruce-Balsam Fir forest predominates with some maple and birch mixed in on less exposed sites. On the wetter soils Black Spruce, Larch and Balsam Fir are found.

Barrens cover many of the headlands, and krummholz vegetation is conspicuous. The parallel quartzite ridge topography gives rise to a fairly regular pattern of White Spruce on the ridge top and Black Spruce and small bog areas in the depressions. Many of the islands have been deforested by the combined effects of exposure and cormorant guano and may not regain a tree cover.

FAUNA

Coastal habitats in this Unit are mostly lowlying rocky shores with some small beach and salt marsh areas. The firm substrate and low sediment supply results in excellent seaweed growth especially along the rocky quartzite shoals which stretch out into the water. Of major interest are the islands which provide important breeding habitats for many waterfowl and seabirds. Together with Unit 842 this forms a major portion of the Common Eider breeding habitat for Nova Scotia. Other breeding birds include cormorants, gulls, Arctic and Common Terns, Black Guillemot, and Leach's Petrel. Considerable numbers of waterfowl migrate through in spring and fall including scoters, Black Duck, Oldsquaw and Canada Goose. Some Oldsquaw, Black Duck and Common Goldeneye remain during the winter. Seals are common on the islands and rocky shoals.

SITES OF SPECIAL INTEREST

Eastern Shore Islands Wildlife Management Area
- extends from Ecum Secum (Little White Island to Sheet Harbour Passage, Round Island.

Little White Island (IBP Proposed Ecological Site 30)
- dense nesting colonies of cormorants and Common Eider Ducks.

Brokenback Island (IBP Proposed Ecological Site 32)
- one of the few breeding sites for the Fox Sparrow in Nova Scotia, also Osprey nests.

Long Island (IBP Proposed Ecological Site 33)
- eider and cormorant nesting site and locality for rare Beach Senecio, Senecio pseudo-arnica.

Pumpkin Island (IBP Proposed Ecological Site 34)
- important nesting site for Leach's Storm Petrel and Black Guillemot.

Horse Island (IBP Proposed Ecological Site 35)
- one of the few islands in the local area which has not been deforested by cormorant nesting.

Provincial Parks and Park Reserves
- Taylors Head
  - sand volcanoes and slump structures.
- Popes Harbour
- Spry Bay
- Ecum Secum
- Marie Joseph

ASSOCIATED TOPICS

T4 Avalon and Meguma Zones, T35 Hardpans.

ASSOCIATED HABITATS

H1 to H9 Coastal Habitats, H17 Barren, H32 Coastal Forest.

840 Quartzite Headlands

GEOLOGY AND GEOMORPHOLOGY

This district is dominated by greywacke/quartzite and granite. The till deposits are relatively thin and there are few drumlins. There are large areas of exposed bedrock.

The coastline is submerged and indented with headlands and long inlets but with few islands. The thin till deposits provide little sediment through coastal erosion, so the coastal fringe deposits tend to be limited in volume and composed of coarse material. Sand beaches only exist where the rising sea level has eroded sand from now submerged glacial deposits and carried it shorewards. Very limited amounts of sand collect locally to form occasional white sand beaches.

SOILS

Shallow soils, low relief, extensive burning and the widespread occurrence of impenetrable ortstein layers have all contributed to produce a predominantly bog and barren landscape in this district.

The district is divided into two units:

841	Capes and Bays
842	Guysborough Harbours

ASSOCIATED TOPICS

T4 Avalon and Meguma Zones, T35 Hardpans.

ASSOCIATED HABITATS

H15 Blanket and Raised Bog.

UNIT 841: CAPES AND BAYS

Granite and greywacke bedrock give a hummocky terrain with little relief. The till cover is variable but often thin. Shallow bedrock and ortstein development impedes drainage, creating bogs. Exposed bedrock and burning has led to the development of barrens. Long sheltered inlets and relatively mild, ice-free winters provide wintering habitat for waterfowl.

GEOLOGY AND GEOMORPHOLOGY

This Unit extends from Lower Woods Harbour in the west to Medway Harbour in the east. The bedrock geology is dominated by greywacke into which several bodies of granite have been intruded. The heat from the largest granite bodies baked the surrounding Meguma sediments and enabled minerals of a high metamorphic grade to form.

Throughout this area granite and greywacke form a hummocky, rather uninteresting terrain with little relief. The coastline is very indented and divided into well developed capes and long narrow bays. The bays are drowned river estuaries.

Glacial till deposits are variable in thickness but are generally less than 10 feet (3 m) deep; bedrock is exposed in fairly large areas especially on the granite. Typically there are very few drumlins on this granite and greywacke bedrock. Three have been mapped around Lockeport Harbour but otherwise they are completely absent. Other glacial deposits include a series of outwash fans along the Medway River and around Medway Harbour.

Little coastal sediment is currently derived from local glacial till deposits. Sand is abundant locally but since it was carried landward from offshore glacial material during the post glacial marine transgression it can now no longer be replaced from the same source. The coastal area is also a high energy wave environment and experiences strong winds. Barrier beaches and dune systems are consequently subject to periodic destruction during storms. The sand is carried either seawards into deep water or carried over the beach into lagoons as overwash. The wide expanse of flat beach created is subject to wind erosion, eventually leading to the recreation of dunes further inland.

SOILS

Soils in this area have mostly developed from coarse-textured parent materials: granite, quartzite and schist. The principle soils are Port Hebert (well drained sandy loam) and Lydgate, its imperfectly drained associate. Both these soils often develop sub-surface cemented layers. Well drained Halifax soils are found between Medway Harbour and Port Mouton, together with imperfectly drained and usually mottled Danesville soils. Lydgate and Port Hebert soils together with areas of rockland, are also found on the granite headlands near Port Mouton. South of Port Hebert, Lydgate soils predominate with extensive areas of Roseway (imperfectly drained sandy loam with organic layers of greasy 'mor') and large organic deposits. Well drained Medway soils (gravelly sandy loam) have also developed in a number of areas from quartzite and schist outwash gravel.

VEGETATION

The low relief, the effects of fire, and the ready formation of ortstein layers, have resulted in large areas of bog and barren. Labrador Tea, Lambkill and blueberries provide the main vegetative cover on the barrens. Elsewhere the forest is chiefly White Spruce and Balsam Fir with maple, birch and poplar. Some pine and Red Oak can be found on better drained sites further inland. In wet, peaty areas Black Spruce, Larch and alders are found.

FAUNA

Coastal habitats include many sand beaches, salt marsh, intertidal muds and sands at the heads of the longer inlets, and cobble beaches. Rocky shores are mostly confined to the shoreline between Liverpool and Port Medway. This section of the coast is on the route for migratory waterfowl and shorebirds. The relatively mild winters and ice-free waters also make this unit a prime wintering area for many species.

Clarks Harbour and Cape Sable are important staging areas for shorebirds with highest concentrations in August. Barrington Bay has extensive mud flats which also attract many shorebirds. Moderate numbers of waterfowl, including Black Duck, scaups and Common Goldeneye, are found there between October and March. During January and February moderate numbers can also be seen at the head of Jordon

Bay and Green Bay. The coast from Lockeport to Port Mouton is very important for wintering waterfowl, particularly Canada Geese and Black Duck. Also present are scaups, Common Goldeneye, Oldsquaw, Common Eider, Loons, Scoters, and the Red-breasted Merganser. Wintering Harlequin Ducks are found in the Port Joli area. St. Catherines River Bay (Cadden Bay) also has the densest breeding concentration of Piping Plovers in the Maritime Provinces (up to 35 pairs). Birds breeding on the scattered offshore islands include gulls, cormorants, Black Guillemot, the Arctic and Common Terns, Leach's Storm Petrel, Osprey and Great Blue Heron.

Offshore, nutrient rich waters provide food for overwintering pelagic seabirds and whales. In the summer warm water incursions, from the Gulf Stream, often bring exotic tropical species to the beaches and inlets in this area.

The area immediately around Barrington Passage is unique in that the population of Red-Backed Voles there exhibit an exceptionally high incidence of melanism (an excess of black pigment which is genetically controlled). The incidence has been calculated at 18.4 percent, compared to 0.01 percent elsewhere in Nova Scotia.

SITES OF SPECIAL INTEREST

Port Joli Federal Migratory Bird Sanctuary,
- chiefly for the protection of habitat for Canada Geese.

Carter's Beach at South West Port Mouton
(IBP Proposed Ecological Site 46)
- illustrates a classic sand dune successional sequence and has the highest dunes in the Atlantic Coast region of Nova Scotia. *Sagima nodosa*, Pearlwort is found in the depressions.

Sandhills Beach in Barrington Bay
(IBP Proposed Ecological Site 49)
- combines a sand dune with a *Spartina*-*Fucus* salt marsh community.

Provincial Parks and Park Reserves
- Port Joli
- Broad River
- Summerville Beach
- Summerville Centre
- Western Head
- Liverpool

UNIT #842: GUYSBOROUGH HARBOURS

A submerged coastline with faults perpendicular to the coast give long, drowned, parallel estuaries separated by greywacke headlands. Thick glacial outwash deposits block the upper reaches of some valleys. Shallow soils give extensive bog and barren development. Light winter snowfall results in important wintering habitat for deer. Sheltered inlets and islands provide important habitat for waterfowl, shorebirds and seabirds. Cold water coast allows little diversity in marine fauna.

GEOLOGY AND GEOMORPHOLOGY

The area encompassed by the Guysborough Harbours Unit extends from Marie Joseph to New Harbour Cove.

The bedrock consists predominantly of greywacke with interfolded slates. The fold axes intersect the coastline at about 45°. Slip movements along th Chedabucto Fault caused a series of parallel faults to develop dividing the bedrock into a number of blocks. These blocks have moved slightly northwards in a step pattern (*en echelon*). Weaknesses in the fault zones has been exploited by rivers producing relatively straight valleys. These have been inundated by the sea so that they now form very long narrow inlets. Sheet Harbour, Indian Harbour, Country Harbour, Isaac's Harbour and New Harbour are all examples of these drowned, fault controlled river valleys. The valleys tend to be narrow and steep-sided providing interesting variety in an otherwise uniform terrain with little relief.

Liscomb Harbour and Fishermans Harbour (near Port Bickerton) have been formed by erosion of the relatively weak slate bedrock. The east-west orientation of these two harbours contrasts with the northwest-southeast orientation of all other harbours. The only comparable feature on the Atlantic Coast region is Yarmouth Sound.

The Unit is mantled with a thin quartzite till derived from the underlying greywacke. A single group of drumlins made up of red-brown till from the Carboniferous strata to the north crosses the area parallel to Indian Harbour River. The drumlins reach the coast between Holland Harbour and St. Marys Bay (Guysborough), where they form coastal bluffs.

There are several large areas of exposed bedrock. Glaciofluvial deposits are well developed along the valleys of Indian Harbour River, Country Harbour River, and the shore of New Harbour. Thick sand and gravel deposits choke the valleys and impede drainage. New Harbour Lake is impounded by a gravel barrier across the valley at Port Hillford.

The coastal sediment supply is limited and there are few sand beaches. Coastal fringe deposits tend to be rocky or cobbly.

SOILS

Most of the soils have developed from medium to moderately coarse textured tills derived from the underlying quartzite. Because quartzite does not weather easily there is only a thin mantle of stoney soil over bedrock; where the relief is more pronounced rapidly drained sandy loams of the Halifax series are found. On the flatter areas the imperfect to poorly drained Danesville and Aspotogan soils predominate. This unit includes large areas of organic deposits and rockland. On the drumlins scattered between Cape St. Marys and Holland Harbour finer textured Wolfville soils (sandy clay loam with moderately slow drainage) have formed. Hebert soils (excessively drained sandy loams) are found along a number of the valleys, formed on glacial outwash sands and gravels.

VEGETATION

On better drained soils the forest is mixed, but predominantly softwoods - White Spruce, Balsam Fir with maple and birch. On the wetter soils the main species are Black Spruce, Larch and Balsam Fir. Huckleberry brush is common on the barren and semi-barren areas, which are extensive.

Little salt marsh occurs along this coast, as so little sediment is available, but there are some Eel Grass beds.

FAUNA

Because the snowfall is considerably less than elsewhere on the coast this Unit forms an important wintering area for deer. Together with adjacent units the highly indented coastline with its many islands provides breeding and feeding habitats for a wide range of waterfowl and shorebirds, both resident and migratory. The area, like Unit 834, is regionally important since it provides a major portion of the breeding and brood-raising habitat for the Common Eider in Nova Scotia. Other breeding species in this area are the Great Black-backed Gull, Herring Gull, Double-Crested Cormorant, Black Guillemot, Common Tern, Arctic Tern and Great Blue Heron.

In the spring substantial numbers of Black Duck, scoters, Common Goldeneye, Canada Goose, Oldsquaw and Red-breasted Mergansers migrate through the area. A number of species are winter residents but are thinly distributed. Oldsquaw, Black Duck, and the Common Goldeneye are fairly common.

Along this cold water coast marine species diversity diminishes from west to east. Freshwater run-off strongly influences coastal water conditions and the distribution of brackish water species.

SITES OF SPECIAL INTEREST

Bickerton Island (IBP Proposed Ecological Site 28)
- typical coastal island nesting area for many species.

Tobacco Island (IBP Proposed Ecological Site 29)
- one of few known nesting areas for Fox Sparrow.

Eastern Shore Islands Wildlife Management Area
- provincial area extending from Ecum Secum Inlet (Little White Island) to Beaver Point (Round Island), Halifax County.
- Goldenville Gold Mine.

Provincial Parks and Park Reserves
- Liscomb Mills

ASSOCIATED TOPICS

T57 Ungulates.

850 Granite Barrens

GEOLOGY AND GEOMORPHOLOGY	Within this District the bedrock is dominated by granite. It forms headlands and knolls which are elevated well above the Upland Surface, and provide some of the most significant relief in the Atlantic Coast Region. The hills have a rounded profile and tend to have a very thin till cover with many large boulders. There is much exposed bedrock. While the thin granite till is a source of quartz grains for occasional white sand pocket beaches, in general the sediment supply is very poor. The shallow impermeable bedrock allows little infiltration and consequently the surface is covered by streams, lakes and bogs.
VEGETATION	Thin acidic soils and frequent rock outcrops restrict tree growth even more than is usually found in the coastal forest. Barrens with ericaceous and stunted krummholz vegetation are widespread.

Within District 850 there are two units:

851	Pennant Barrens
852	Canso Barrens

ASSOCIATED TOPICS

T5 Granite in Nova Scotia, H48 Rare Plants.

ASSOCIATED HABITATS

H11 Freshwater Lake, H14 Blanket and Raised Bog, H32 Coastal Forest.

UNIT 851: PENNANT BARRENS

This granite promontory, elevated above the surrounding upland surface, with thin rocky tills and exposed bedrock, gives extensive coastal barrens with bogs. Exposed conditions provide habitat for some rare arctic-alpine flora. Generally the shore line is rocky; in places it has been swept clear of all sediment and is bordered by a boulder, cobbleshore.

GEOLOGY AND GEOMORPHOLOGY

The Pennant Barrens include the promontory between Halifax Harbour and St. Margarets Bay and part of the Aspotogan Peninsula. The area is underlain entirely by granite which forms knolls elevated up to 500 feet (150 m) - well above the planation surface.

Joints within the granite divide it into large blocks. At the shoreline these can be loosened and moved by storms, providing some dramatic coastal topography as at Peggys Cove. There are also steep cliffs which were probably formed in the Early Carboniferous and later buried by younger deposits. Now that the sedimentary cover has been eroded away they are exposed once again, e.g. Chebucto Head. Granite islands and shoals have formed as the headlands became submerged. Similarly the lower reaches of rivers have been drowned and form long inlets (eg. Shad Bay).

The surface of the granite has a patchy thin covering of granite till. There are many areas of exposed bedrock where glacial striations can be seen. The till contains many boulders of varying size (erratics) which are dumped randomly across the landscape giving it a bulldozed appearance. The sediment supply is very limited and only the accumulation of sediment carried inland by the transgressing sea has provided enough sand for beaches such as Crystal Crescent.

The surface of the granite has a deranged drainage pattern with many lakes interconnected by wandering slow-moving streams.

SOILS

The main soil found in this area is Gibraltar (well-drained sandy loam), with small areas of poorly drained Aspotogan and peat. A strip of Bridgewater soil (well drained shaly loam derived principally from slate) is followed by the road through Hatchet Lake. A number of small drumlins with Wolfville soils occur, particularly between Spryfield and Pennant.

VEGETATION

Much of the area is covered by coastal barrens, with lichens, Broom Crowberry, and Reindeer Moss, interspersed with small sphagnum and sedge bogs. Where exposure to wind and spray is most severe stunted White Spruce is usually found. Black Spruce, Larch, and Balsam Fir occur on more sheltered sites, with maple and birch (H.32). Further inland, stands of post-fire maple, oak and birch (H.22) occur on well drained sites. Jack Pine can also be seen. Some arctic-alpine species are present (see T16 Colonization by Plants).

Commenting on this enormous fire barren in 1912 C.D. Howe wrote: "The largest fire barren in Halifax county lies between St. Margaret bay and Halifax harbour,.... (and) .... is chiefly barren of commercial trees, the forest being composed, ... of wire birch, red maple, alder and poplar, and frequently it has scattered white pine of polewood size reaching up above them. The soil is sandy and is filled with pebbles and boulders. In many places the bare rock is exposed, and the surface strewn with granite boulders. The tops of the sandy knolls where the soil is deep frequently support young red oak. On the more moist, deeper soil of the slopes one finds scattered patches of thrifty hardwoods from twenty to forty years old. In one of these patches the composition of the stand was as follows: fir 24 percent, black spruce 16 percent, yellow birch 21 percent, shad tree seven percent, red maple 19 percent, mountain ash two percent, paper birch one percent."

FAUNA

The shoreline is mainly rocky with low cliffs, some islands and a few sand beaches; it does not provide much suitable habitat for shorebirds or waterfowl. Breeding birds include gulls, cormorants, osprey and the Great Blue Heron. There are a few Bald Eagle breeding sites and Double-crested Cormorant colonies. Slope water influence often results in productive plankton areas and the presence of whales, particularly in the late summer. Small mammal diversity in the vegetation on the barrens is low (three or four species). Populations also appear to be low except in close proximity to freshwater.

SITES OF SPECIAL INTEREST

Bear Cove (IBP Proposed Ecological Site 38)
- an example of a small coastal bog.

Duncan's Cove (IBP Proposed Ecological Site 39)
- is a large area of coastal barrens with a number of rare plants.

West Dover (IBP Proposed Ecological Site 40)
- is an example of a lichen-dominated, virtually treeless barren.

Portugese Cove
- contact between granite and Meguma sediments; loose blocks of country rock can be seen 'floating' in the granite.

Chebucto Head
- large white crystals of felspar showing flow patterns within the granite.

Crystal Crescent
- relict white sand beach.

Provincial Parks and Park Reserves
- Holahan Lake
- West Dover
- Blind Bay
- Terrance bay
- Crystal Crescent Beach
- Herring Cove

UNIT 852: CANSO BARRENS

Granite knolls rise prominently above the surrounding upland surface. The straight northern coastline is fault controlled in contrast to the indented south-eastern coastline which has many bays and bedrock islands. Extensive areas of exposed rock give barrens a moonscape appearance. There is some seabird breeding habitat on islands.

GEOLOGY AND GEOMORPHOLOGY

The Canso Barrens extend northeastwards from New Harbour to Cape Canso. Geologically the area is composed of rounded bodies of granite which have been intruded into Meguma slates and greywacke. The Meguma Group greywacke and slates have been extensively metamorphosed to form schists. All bedrock components have been affected by shearing movement along the Chedabucto Fault. The granite appears as knolls in the landscape, rising up to 650 feet (200 m) above sea level.

Thin surficial deposits of granite, schist and slate tills cover about 50 percent of the surface but the remainder is exposed bedrock. This gives the area a bleak moonscape appearance. A few drumlins composed of red-brown till derived from Carboniferous deposits are found on the north-eastside of Tor Bay and south of Canso Harbour. There is a very limited supply of coastal sediment.

The shape of the coastline reflects two influences: the presence of the Chedabucto Fault on the straight northern coast and submergence on the southern shore. New Harbour is a long narrow inlet formed by the inundation of a fault controlled river valley. Glacial outwash deposits are found along a 4 mile (7 km) section of the valley and block the drainage at two points creating two ribbon lakes.

SOILS

Over much of the area soils are very thin or non-existent. Over the granite, where soil cover has developed, there is mostly Gibraltar soil (well drained sandy loam). On the flatter areas near the coast Danesville gleyed Podzol (imperfectly drained sandy loam) is common. In the middle of the Canso peninsula, Bridgewater soils (well drained shaly silt loams) have developed on the slate, interspersed with many boggy areas. Small, finer-textured Wolfville drumlins are strung out along the road to Canso and near Port Felix. Around Larry's River there is an area of excessively drained Nictaux soil on outwash sands and gravel.

VEGETATION

Where there is enough soil for trees to become established they are mostly Black Spruce and Balsam Fir in dense stands with some White Spruce, maple and birch (H.32). On wetter areas Black Spruce and Larch predominate. The presence of Jack Pine on the Canso peninsula indicates that extensive fires have occurred. Vegetation on the barrens includes Sheep Laurel, Huckleberry brush, Labrador Tea, scrubby Black Spruce, Bracken and alders.

C.D. Howe's 1912 comments on the "forests" of this unproductive area follow: "The bare rock is largely exposed and is strewn with boulders. The soil cover in the drier portions is not over two inches deep and is composed of raw humus. The deeper soils are of the same nature and both are covered with small herbs and shrubs. The crevices of the rock and the depressions are filled with alder and stunted black spruce and fir."

Rocky shores provide good substrate for rockweed and kelp growth.

FAUNA

The large areas of barren do not provide productive wildlife habitat. The rocky south-eastern coast provides breeding grounds for gulls, the Double-crested Cormorant, Great Blue Heron, Arctic Tern, Common Tern, and Common Eider (see description of Unit 842). The cobble beaches and cliffs, and the lack of inlets and islands make the Chedabucto Bay coast much less interesting in terms of waterfowl. A cold water shore with little slope water influence means that marine productivity is diminished, and the marine fauna impoverished. The arctic indicator species Mysis gaspensis, a crustacean, occurs here.

SITES OF SPECIAL INTEREST	Along Highway 16 - fault scarp of Chedabucto Fault Provincial Parks and Park Reserves - Cape Ann Island - St. Andrews Island - Third Lake - Harbour Head - Tor Bay

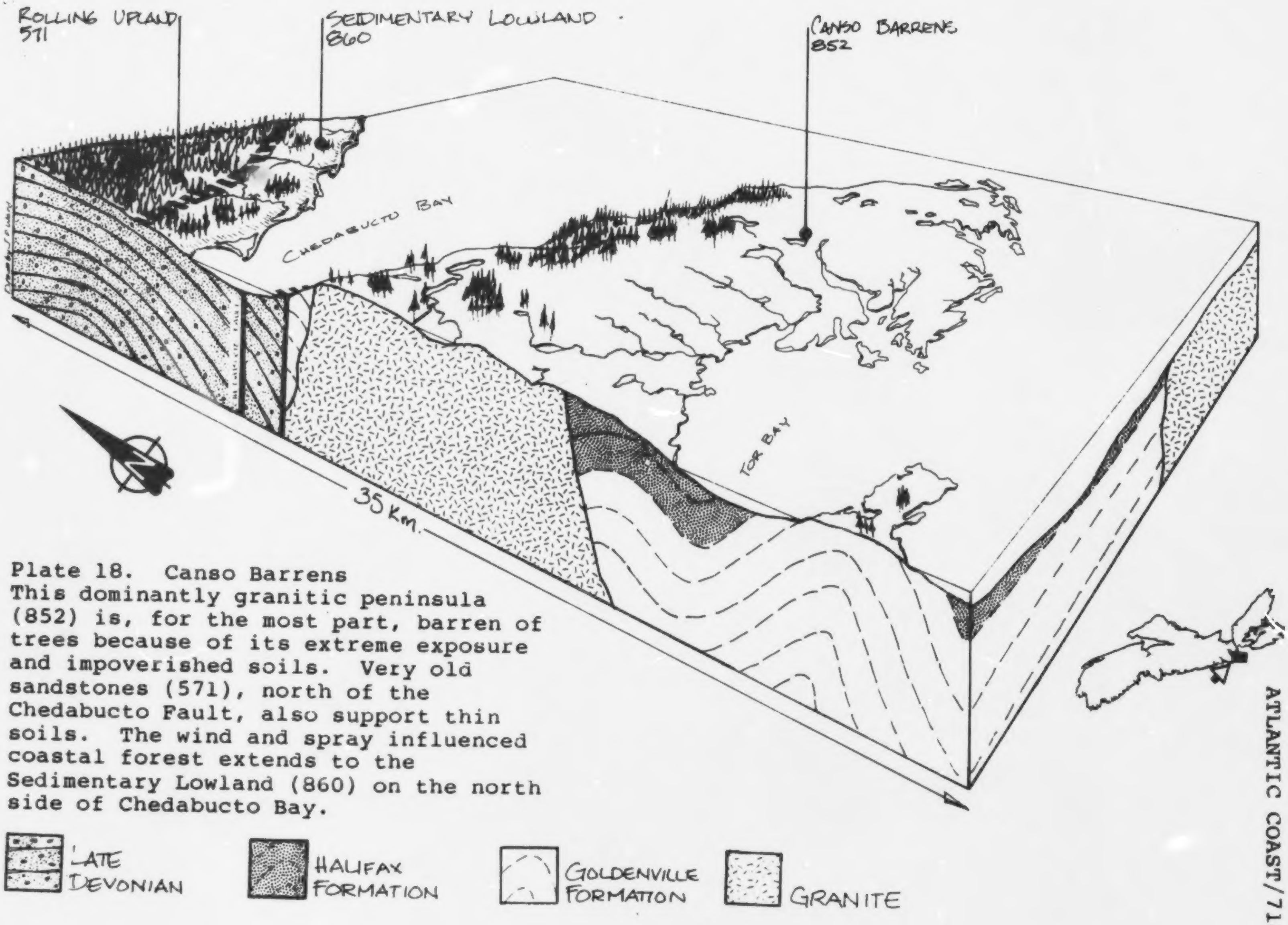

ROLLING UPLAND
571
SEDIMENTARY LOWLAND
860
CANSO BARRENS
852
CHEDABUCTO BAY
TOR BAY
35 Km.
LATE DEVONIAN
HALIFAX FORMATION
GOLDENVILLE FORMATION
GRANITE

Plate 18. Canso Barrens
This dominantly granitic peninsula (852) is, for the most part, barren of trees because of its extreme exposure and impoverished soils. Very old sandstones (571), north of the Chedabucto Fault, also support thin soils. The wind and spray influenced coastal forest extends to the Sedimentary Lowland (860) on the north side of Chedabucto Bay.

860 Sedimentary Lowland

Chedabucto Bay is the largest bay on the Atlantic Coast and was formed by the drowning of part of an ancient river system. The river developed on the erodable Carboniferous sediments which can now be seen on the lowland margins on the Bay. Various soils have developed on deep tills and include extensive clay soil areas. This part of the Atlantic Coast Region is more sheltered but the coastal forest still dominates. Freshwater habitats are more productive than elsewhere in the Region. Water temperatures which are warmer in the summer than on more exposed coasts support some southern marine fauna species.

GEOLOGY AND GEOMORPHOLOGY

Chedabucto Bay lies immediately to the east of the Horton Sandstone Rolling Upland District (570) of the Carboniferous Lowlands. Geologically it is dominated by sedimentary rocks deposited during and after the formation of Pangea in the late Devonian and Carboniferous Periods.

Apart from slices of Precambrian Fourchu volcanics which have been faulted up against younger rocks on Isle Madame, the oldest deposits in the district are coarse conglomerates including some volcanics. These were deposited during the unsettled period from Late Devonian to Early Carboniferous when major crustal movement and adjustment was taking place in Nova Scotia. These conglomerates and related deposits are extensively exposed in eastern Guysborough County, Isle Madame and between L'Ardoise and Loch Lomond.

The succeeding deposits are salts (Windsor Group) reddish siltstones (Canso Group) and fine sandstones (Riversdale Group). All these rocks are relatively soft and erodable. Topographically they have formed a rolling lowland which slopes towards Chedabucto Bay and the Strait of Canso

LANDSCAPE DEVELOPMENT

Chedabucto Bay owes its origin and shape to a number of factors. Its southern boundary marks the position of the Chedabucto Fault which extends across central Nova Scotia from the Bay of Fundy to the Canso peninsula. This fault line, the Strait of Canso, and Chedabucto Bay itself were probably part of a major river system which rose on the continental shelf and flowed northwards into the Gulf of St. Lawrence during the Triassic and Cretaceous periods. Later, tilting and submergence drowned the valley, creating both the Bay and the Strait.

Glacial ice moving into the Bay from the northwest and from local ice caps deposited a locally derived red-brown sandy till across the Carboniferous rocks. Drumlins are entirely absent on the northwest side of the Bay but are common in the eastern part where they have an eastwest (Isle Madame) or northwest-southeast orientation. Consequent rivers rising in the uplands flow southwards across the Carboniferous lowland into the Bay. Inhabitants River, the largest in the District, rises in the Maple Brook area south of the Creignish Hills and exits into the Bay through a drowned valley. Marine erosion provides abundant coastal sediment for numerous small gravel beaches. The beaches often enclose small lagoons or salt marshes.

SOILS

The soils in this area have developed for the most part from sandstones, slates and shales, giving tills ranging in texture from sandy loam to shaley clay loam. In Guysborough County mottled, imperfectly drained clay loam Millbrook soils are common. The better drained Westbrook sandy loam is found around Guysborough Town. Riverport (imperfectly drained shaly loam) and Kirkhill (sandy loam) soils have both developed from shales. On Cape Breton Island the western section of this district has more Millbrook soils, imperfectly drained Diligence and Queens clay loams and poorly drained Kingsville soils. Further east, including much of Isle Madame, soils have developed from stoney tills derived from hard sandstones and angular metamorphic rocks. They are the same as those found in the Louisbourg area i.e. Thom and Arichat soils, with extensive peat deposits.

Along the Inhabitants River the soils are a complex mix of peat, alluvial fine sandy loams known as Kingsville, Cumberland and Bridgeville soils, and the coarse Hebert series which has developed on outwash gravels.

VEGETATION

Although this part of the Atlantic coast is more sheltered the coastal forest is still manifest with the predominant forest association being White Spruce, Balsam Fir with maple and birch (H.32). On the clay Queens soils of Cape Breton sections of this district Balsam Fir and Black Spruce are the dominant species with scattered intolerant hardwoods. Some aspen also occur especially in disturbed areas. Barrens and bogs are common, particularly on Isle Madame. Old farmland is found mainly on the clay soils, and is mostly regenerating in pure White Spruce. The low coastal relief and abundance of sediment give areas of salt marsh, but significant local winter ice action restricts the growth of seaweeds.

FAUNA

The Bay is not a very productive area for waterfowl or seabirds, because there are few undisturbed islands, and sea ice in winter restricts feeding from open water. However the salt marsh and estuary areas do provide some wading bird habitat (heron and shorebirds).

Warm water temperatures in summer permit the reproduction and survival of some more southerly marine species. Many of them are also found in the Gulf of St. Lawrence but are no longer able to interact freely with those in the Bay because of the presence of the Canso causeway. The diversity and numbers of epifauna are restricted by ice action. Whales are sometimes seen in the Bay.

The River Inhabitants provides rich aquatic habitat, and is important for nesting Wood Turtles. Freshwater lakes on Isle Madame contain interesting residual fauna with a more continental distribution, including the freshwater clam *Lampsilis radiata*.

SITES OF SPECIAL INTEREST

Provincial Parks and Park Reserves

- Mast Cove
- Boylston
- Ragged Head
- Dorts Cove
- Kempt Road
- Louisdale
- Lennox Passage
- Cap La Ronde
- Pondville Beach
- Arichat
- Cove Road

ASSOCIATED TOPICS

T6 The Carboniferous Basin: An Inland Sea, T59 Land and Freshwater Invertebrates.

ASSOCIATED HABITATS

H1 to H7 Coastal Habitats, H11 Freshwater Lake, H12 Slow-moving Stream, H18 Oldfield, H32 Coastal Forest.

870 Till Plain

This is a lowlying, almost flat, area with a highly eroded bedrock surface thickly covered with glacial till, sands and gravel. The poorly drained surface gives numerous bogs, swamps, lakes and wandering, slow-moving streams. A rocky coastline in the east gives way to a coast dominated by barrier beaches in the west. Balsam fir is the dominant tree species with Black Spruce and Larch in wetter areas. Limited snow cover provides good deer wintering habitat. Abundant offshore marine life thrives on plankton rich, upwelling cool coastal waters.

GEOLOGY AND GEOMORPHOLOGY

The Till Plain lies on the southeastern side of Cape Breton on the lower side of the tilted planation surface. The bedrock is dominanted by Precambrian Fourchu volcanics with large outcrops of Cambrian granite and metamorphic sediments of varied composition. The bedrock surface is highly eroded and is presumed to be almost flat under the glacial deposits. This is difficult to verify since the whole district is covered by a thick layer of glacial till, sands and gravels with the bedrock exposed only along the coast.

The bedrock is cut by numerous, parallel, northeast-southwest trending faults along which vertical movement has taken place. Gabarus Bay is believed to be the product of downfaulting along another set of faults oriented northwest-southeast.

Surfical Deposits and Landscape Development

Glacial ice from the exposed Scotian shelf flowed onshore and then northeastwards during the Wisconsin glacial period depositing a thick mantle of sands and gravels across the entire area. The thickness is variable but it commonly achieves 100 feet (30 m), with 60 feet (12 m) representing an average depth. Drumlins are common. The glacial deposits have completely altered the original drainage pattern. The surface is now covered with irregular lakes and wandering streams.

Inland the terrain is low-lying and rolling, rising across a series of ridges to about 400 feet (125 m) in the northwest. A dominant landscape feature is the Mira River Valley which extends from Framboise Cove northwards to about Marion Bridge then sweeps eastwards to exit at Mira Bay. Its preglacial flow, which may have been to the south, was redirected by small changes in elevation and blockage of the original exit by glacial deposits. The lower reaches of the river have been dammed by glacial gravels to form a long lake. At Mira Bay the river funnels through a very narrow valley, in places only 165 feet (50 m) wide, with steep banks 65 feet (20 m) high.

The coastline of the Till Plain is relatively even and dips gently into the sea. Gabarus Bay is the only stretch of coast where sea cliffs are found. Sediment supply along the coast is variable. North of Gabarus, rocky shorelines, boulders and cobble beaches are most common, south of Gabarus the coast is indented with protected bays. Sand and gravel beaches are numerous. Between Point Michaud and Fourchu Bay an extensive series of cobble barrier beaches enclose large barachois ponds. These beaches may have originally formed offshore and moved landward as sea level rose.

SOILS

The soils in this District illustrate how strong podzol development associated with the climate along the Atlantic Coast can over-ride the effects of different parent materials. The soils have developed from sandstones, quartzites and shales. The most common soil series is Thom - a well drained sandy loam Podzol, usually associated with cooler and wetter highland areas such as the Cobequids. A feature of Thom soils is the accumulation of organic matter on the surface and B horizon. Closer to the coast the imperfectly to poorly drained associates, Mira and Arichat, are more common.

On the granites around Lower St. Esprit, Gibraltar and Aspotogan soils are found. Shulie sandy loams occur between Loch Lomond Lakes and the Mira River. These are similar to soils in district 532 to the north. To the east of the Mira River well drained Kirkhill soils occur. These have a shaley loam texture and are relatively deep and free of stone. Ortstein layers are common in this District and large areas of peat have built up.

VEGETATION

The main controlling factors in this District are the cool, wet soils, the marine exposures, widespread disturbance, and insect damage. Along the coast White Spruce is common, but inland Balsam Fir grows much better and is the dominant species. Some intolerant hardwoods with lesser amounts of tolerant hardwoods are found on better drained soils inland. Black Spruce and Larch are common in wet depressions. Hemlock was once common but is now rare, presumably having been removed by selective logging by early settlers. Spruce Budworm is endemic here.

Large bogs are a prominent feature. Considerable quantities of Bakeapple are found in the bogs on Scatarie Island, on exposed headlands and other coastal bogs and barrens. Heath vegetation, particularly Crowberry, is found on exposed headlands.

Sand dune and saltmarsh communities with some beds of Eel Grass are found along the coast. Limited warm water influence in summer has permitted the penetration of some marine plant species from the Gulf of St. Lawrence, such as Serrated Wrack, (Fucus serratus), but the marine flora is restricted by the cold water and ice action.

FAUNA

Low snowfall in the winter provides good deer wintering habitat in this District. Staging areas for migratory waterfowl and shorebirds are found along this coast between Fourchu Bay and Framboise Cove. The islands provide important breeding habitat for seabirds. Green Island has the most southerly nesting colony of Black-legged Kittiwakes, and is the only one known in the Maritimes. Elsewhere breeding populations of gulls, cormorants, Black Guillemots, and Common Eider can be seen. Pelagic seabird concentrations occur off Louisbourg, and are probably associated with an area of deepwater upwelling. Ptarmigan and Arctic Hare have been introduced to Scatarie Island.

The Louisbourg Lowland is a cold water coast with extensive sea ice resulting in an impoverished marine fauna of an exposed boreal character. Harbour Seals are common; Grey Seal used to breed on the Basque Islands.

SITES OF SPECIAL INTEREST

Point Michaud (IBP Proposed Ecological Site 26)
- beach and sand dune system showing succession from bare sand to White Spruce forest.

Scatarie Island
- Provincial Wildlife Management Area with bogs and barrens.

Little Lorraine to Big Lorraine
- barren, rocky headlands with interesting flora.

Gooseberry Cove
- a hanging bog, nesting sites.

Baleine
- artic-alpine flora

South Head
- bog contains *Calopogon pulchellus*

Louisbourg National Historic Park
- bogs, barrens and forest.
- Precambrian volcanic ash, vent deposits and dykes.

Green Island
- nesting site for Black-legged Kittiwakes.

Main a Dieu
- exposed cobble beach

Hilliards Lake, Winging Point Lake, Belfry Lake, Marcoche Lake
- barachois ponds enclosed by barrier beaches.

Road between Marion Bridge and Albert Bridge (south side of Mira River)
- fossiliferous Cambrian sandstones and shales.

Provincial Parks and Park Reserves
- Point Michaud Beach
- St. Esprit
- Belfry
- Main-a-Dieu

ASSOCIATED TOPICS

T4 Avalon and Meguma Zone, T35 Hardpans, T36 Algae.

ASSOCIATED HABITATS

H1 to H5 Coastal Habitats, H14 Blanket and Raised Bog , H17 Barren, H32 Coastal Forest.

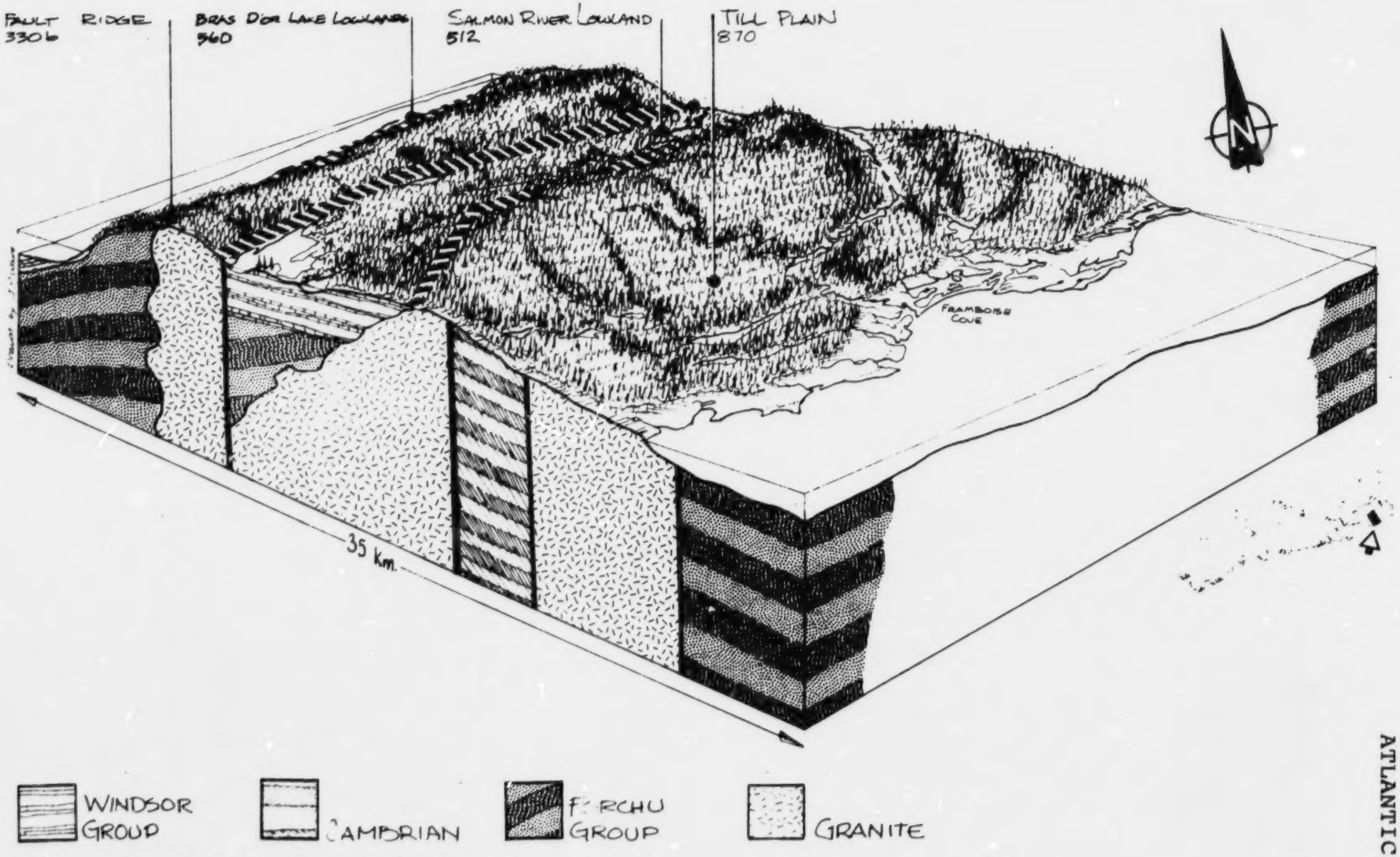

FAULT RIDGE
330b
BRAS D'OR LAKE LOWLANDS
560
SALMON RIVER LOWLAND
512
TILL PLAIN
870
N
FRAMBOISE COVE
35 Km.
WINDSOR GROUP
CAMBRIAN
FORCHU GROUP
GRANITE

Plate 19. Louisbourg Lowlands

Glacial deposits mask the very old rocks of this Till Plain (870); at the coast reworking of these sediments has created an extensive system of barrier beaches and coastal lagoons. Inland, softer rocks are preserved in the downfaulted Salmon River lowland. Windsor Group rocks are also found on the lowland fringe (560) of Bras d'Or Lake, abutting the resistant upland known as the East Bay Hills (330).

880 Cliffed Island

GEOLOGY AND GEOMORPHOLOGY

St. Paul Island is 15 miles (25 km) northeast of Cape North in Cape Breton. It is 3 miles (5 km) long, and peaks at 400 feet (147 m) high on Corgan Mountain. It is accompanied by a much smaller island, The Tickle, which is only 1,000 feet (300 m) long. Geologically the island is part of the Cape Breton Highlands. Most of the gneiss and schist from which the island is formed belongs to the Precambrian George River group, although some slightly younger Fourchu group rocks are found on the north-east coast.

Almost vertical sea cliffs surround St. Paul Island, except on the southwestern side. A sloping plateau surface, reminiscent of the Cape Breton Highlands, occupies most of the island. It has an average elevation of 330 feet (100 m) above sea level much lower than that of the Highlands, 1,700 feet (500 m). There is no sheltered anchorage; the shoreline is scoured by sea ice moving out of the Gulf of St. Lawrence in spring. Storm waves attack the cliffs at all times of the year.

VEGETATION

Despite its lower altitude the plateau surface is exposed to winds comparable to those in the Highlands Taiga Region (100). The response of the vegetation is similar, with stunted spruce-fir coastal forest (H.32) dominating the island. Barrens, bogs and the exposed cliffs are home to a number of northerly species not normally found in Nova Scotia as follows:

a) Barrens: Bearberry Willow and Alpine Whortleberry both of which have widespread boreal distributions, but are rare in Nova Scotia.
b) Bogs: the sedge *Carex gynocrates*, the orchid Grass Pink and the Bog Birch are all found in bogs and wet depressions. All are widespread but rarely find the right habitat in Nova Scotia.
c) Cliffs: *Oxytropis johannensis*, one of the Pea family of flowering plants, is found here and on other exposed cliffs particularly around the Bay of Fundy.

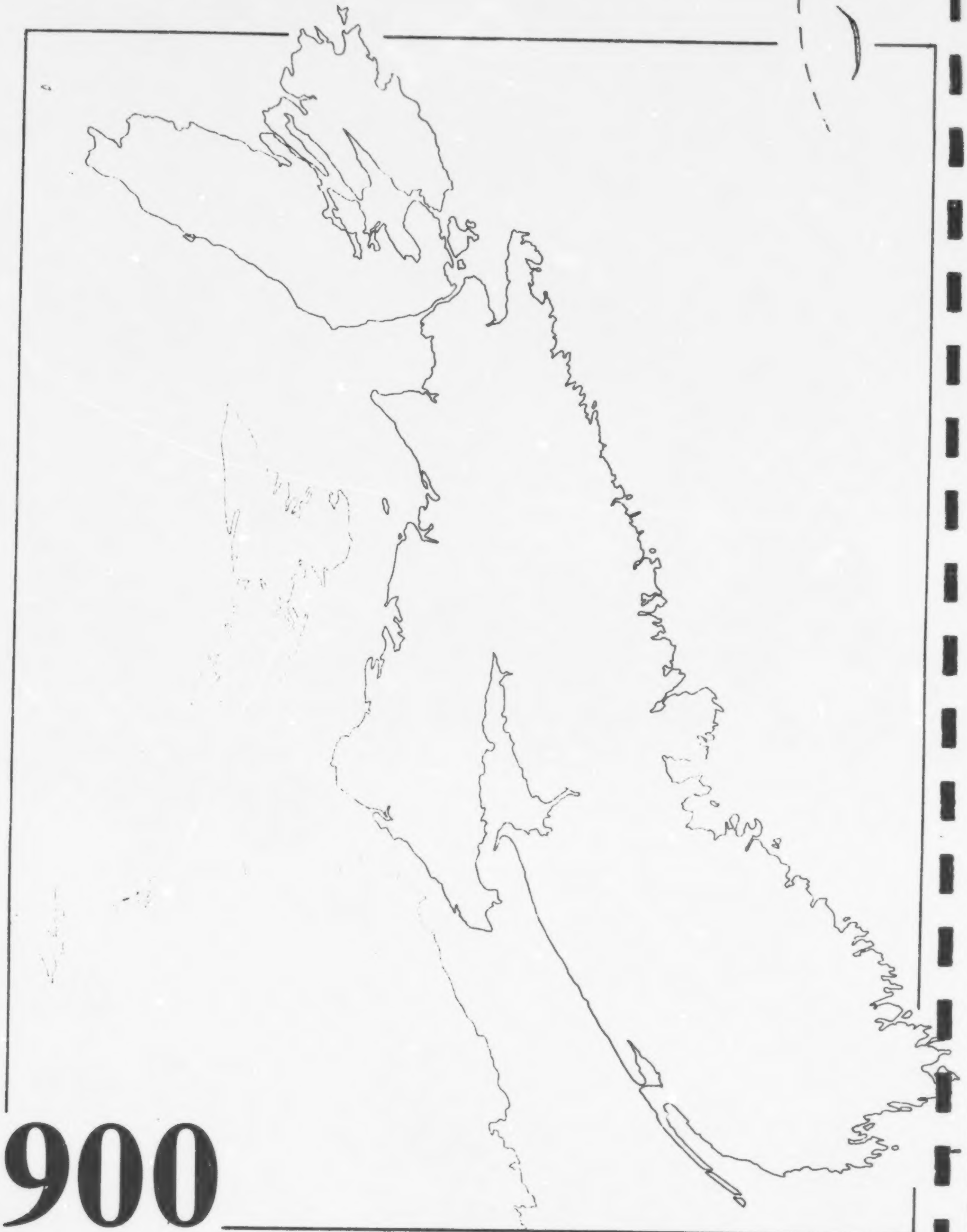
d) Shorelines of ponds and streams: the Butterwort and Birdseye Primrose, although the latter has a more southerly distribution.

ASSOCIATED TOPICS

T16 Flora, T48 Rare Plants.

ASSOCIATED HABITATS

H1 to H3 Coastal Habitats, H14 Blanket and Raised Bog , H17 Barren, H19 Cliff, H32 Coastal Forest.



900

900 SABLE ISLAND

900 Sandy Island

REGIONAL CHARACTER -IZATION	Sable Island is entirely composed of sand. Constant winds, salt spray and shifting sand form an environment hostile to trees and shrubs. Climatic winter and summer extremes are modified by the oceanic influence. The island is a prolific breeding ground for some marine mammals and is home to an introduced species of horse which removes vegetation and contributes to the instability of the sands.
GEOLOGY	Sable Island is an elongated sand island which lies 180 miles (300 km) east of Halifax. It is oriented east-west and measures 26 miles (42 km) by 0.75 miles (1.4 km) at low tide. Shallow bars extending underwater at either end give it an overall length of 50 miles (80 km). The island is the emergent part of a very large sand deposit on Sable Island Bank which occupies an area measuring 150 miles by 70 miles (250 km by 115 km) on the Scotian Shelf. Beneath the sand is a wedge of Cretaceous and Tertiary sediments which thickens seaward and is currently being actively surveyed and drilled for hydrocarbon deposits.
	The sand was deposited in a sand/gravel mixture as an outwash fan from a late Wisconsin ice front which approached but never covered Sable Island Bank. As glacial ice melted and sea level rose the sand was winnowed out. Tides and wind-driven currents now keep it in continuous motion within a circulating 'sand-cell'. The sand moves around the island removing and replacing sand on the emergent part of Sable Island.

MORPHOLOGY

Sable Island itself has the shape of a shallow crescent which is concave northwards. It consists of two lines of high dunes which were originally separated by a tidal gap. The southern range has now disappeared into Wallace Lake leaving a wide beach area. The form of the island changes constantly as the incessant strong winds and frequent storms shift the sand around the island and back and forth from the offshore. The beach profile undergoes normal seasonal changes; steeply inclined in the winter and gently inclined in the summer.

Records and maps for the past 200 years or so show that though the island has changed its form it has more or less maintained the same position and overall size. The eastern half, though more stable than the western half, has decreased in altitude from 165-80 feet (50 to 24 m) at its highest elevations. The violent storms which have caused considerable changes in morphology on the island seem to be counterbalanced by a slow rebuilding process during quieter periods when sand is added from offshore.

CLIMATE

The climate of Sable Island is characteristically maritime with a narrow range of temperature and high winds. Sable Island is warmer in winter and cooler in summer than the neighbouring mainland. During the summer fogs are frequent as warm moist southerly winds blow from the warm Gulf Stream over the cold Labrador Current.

Mean daily temperatures in January hover around 32°F (0°C). In April they rise to approximately 39°F (4°C). By July mean daily temperatures are around 59°F (15°C). In comparison to the mainland, the temperature regime on Sable Island shows a slightly lower annual mean maximum and a much higher annual mean minimum.

The total annual precipitation is intermediate between that of Halifax, and Truro. Only a very small proportion falls as snow because of the mild winter temperatures. The snow that does fall does not linger.

Comparison of Climatic Records:

Mainland Nova Scotia and Sable Island

	Truro	Halifax	Sable Island
Annual Mean Maximum °F(°C)	52(10.9)	53(11.5)	50(10.1)
Annual Mean Minimum °F(°C)	32(0.1)	38(3.6)	46(7.7)
Total Annual Precipitation inches (mm)	44(1,100)	52(1,300)	51(1,270)
Mean Annual Sunshine Hours	1,900	1,750	1,450
Average Monthly Windspeeds mph (km/hr)	9(14)	11(18)	16(26)

Cloud or fog cover over Sable Island is frequent; the mean number of hours of sunshine is substantially lower than at the two mainland stations. The incidence of foggy days increases between April and August. July is the foggiest month; fog occurs on average 21 days out of the month. Average monthly windspeeds are significantly higher as strong winds blow for more of the time and the exposure is much more on Sable Island than on the mainland.

The main features of the bio-climate are the mild temperatures, the constant high winds and the high humidity.

SOILS

There is no soil development (that is identifiable soil horizons) because of the constant shifting of the sandy substrate. In more sheltered areas in the central part of the island there has been some formation of peat. Podzolization occurred in the past when the sands were more stable but only remnants now remain.

LIMNOLOGY

Rainwater filtering through the sand collects to form a freshwater lens which, by displacing sea water, appears as freshwater pools in depressions. The pH of most of these pools varies from 5.0 to 5.7. Brackish ponds receive seawater inputs during storm surges, and both their size and water chemistry can change quite dramatically. The major brackish pond is Wallace Lake. Factors influencing the physical and chemical characteristics of pools on Sable Island include fluctuating water levels, use by horses (grazing and trampling), and nutrient enrichment from colonies of gulls and terns.

VEGETATION

The main influences on the regional vegetation are the high winds, salt spray, sand-blasting, the lack of soil, and the effects of grazing by the Sable Island horses. The variety of plants found on the island has been extended by numerous introductions, both deliberate and accidental. A total of 127 native and 28 introduced plants have been noted.

Trees cannot survive the effects of wind and salt damage. In 1901, in a massive attempt to stabilize the dunes, over 80,000 softwood and hardwood trees were transplanted. Almost all died immediately, and by 1981 only one, a maple, remained. Two pine trees planted in the early 1970's are barely surviving.

In a botanical study completed in 1981 plant communities were divided into several categories: Sandwort, Dense Marram, Sparse Marram, Marram-Fescue, Shrub Heath, Cranberry Heath, and Pond-edge Herbaceous. The first three communities are marked by a relatively low species diversity, which increases through the remaining communities. The greatest diversity is found at the edges of the freshwater ponds.

In the Sandwort community nearly all the cover is provided by Sea-beach Sandwort. The most important species in the Dense Marram community are American Beach-grass, Beach-pea and Yarrow. American Beach-grass is the most important species in the Sparse Marram community, with Beach-pea and Seaside Goldenrod. In the Marram-Fescue community American Beach-grass is joined by Red Fescue and a number of other species.

In the Shrub Heath community Black Crowberry, Common Juniper, Bayberry, Wild Rose, Blueberry and Heather (in one area) are common plants. In the Cranberry Heath community, Cranberries are joined by such plants as Baltic Rush, Bayberry and Aster.

Freshwater pools are usually fringed by a wide variety of plants, such as Bulrush, Iris, Spike-rush, Baltic Rush and Lance-leaved Violet, usually grading into the Cranberry Heath. In the brackish ponds Ditch-grass and Sago Pond-weed grow, surrounded either by bare sandy margins or salt-tolerant plants. The only plant to grow in very brackish water is Eel Grass.

FAUNA

Sable Island provides sand beach, sand dune, and heathland habitats, with a number of fresh and brackish pools. The fact that it is the only landfall for hundreds of miles also ensures that it receives many migratory and marine visitors. The only terrestrial mammal now found on the island is the horse. It is not known whether the Sable Island horses were deliberately introduced from New England in the 18th Century, or whether they arrived earlier either deliberately or from shipwrecks, with one of the many French expeditions. The population fluctuates with food supply (mainly Marram Grass), and in recent years has varied between 150 and 350. At one time there were 500 cattle on the island and pigs roamed wild. Both Grey and Harbour Seals whelp on the island, and whales and dolphins are quite regularly washed up on the beaches. A number of other mammals have at one time been introduced to the island, including rats, cats, rabbits, and foxes, but all are now extinct.

A total of 478 species of insect have been recorded on the island. The pattern of their distribution in North America has given rise to theories that Sable Island may have acted as a coastal plain refugium during the Pleistocene glaciation. Insects have also been introduced with livestock, vegetation and shipwrecks. A number of rare and unusual insects occur on Sable Island. More than 100 other invertebrates also occur.

Five species of fish, the Mummichog, American Eel, Black-spotted Stickleback, Ninespine Stickleback, and Fourspine Stickleback, are found in the fresh and brackish water pools. All five species are capable of crossing stretches of salt water to reach the island.

Birds that breed on Sable Island include Starling, Great Black-backed Gull, Herring Gull, Arctic Tern, Common Tern and Roseate Tern, Spotted Sandpiper, Least Sandpiper, Semipalmated Plover, Black Duck and Red-breasted Merganser. The most famous breeding bird is the Ipswich Sparrow, which breeds exclusively on Sable Island. A great variety of migrant birds appear on the island from time to time.

ASSOCIATED TOPICS

T9 Offshore Geology and Resources, T14 Deglaciation and Glacial Deposits, T15 Post-glacial Climatic Change, T21 Ocean Currents, T24 Modifying Forces, T28 Offshore Bottom Characteristics, T48 Factors Influencing Avifauna, T61 Marine Fishes, T62 Marine Mammals.

ASSOCIATED HABITATS

H1 Benthic, H2 Open Water, H5 Sandy Shore, H8 Coastal Freshmarsh, H10 Dune System.

GLOSSARY

Acadian	A time of mountain building during the Devonian period.
Alleghenian species	Plants associated with deciduous forests to the south (see T16).
Alluvial deposits	Material deposited by a river, usually sand or gravel.
Altered rocks	Rocks whose nature has been changed by geological processes.
Amphipods	A group of Crustaceans which includes freshwater shrimps.
Amygdaloidal	A rock containing gas bubbles trapped in lava which were subsequently filled with minerals, often semi-precious.
Anadromous	Used to describe fish that spawn in freshwater after spending most of their life in the sea.
Anhydrite	Anhydrous calcium sulphate. A common mineral in evaporite deposits, usually occurring in massive beds.
Anticline	A fold in the layers of rock caused by deformation of the earth's crust. The older strata are towards the centre of the fold.
Arctic-alpine	Plants which would more typically occur at a more northerly location or at a higher elevation.
Association	A group of species living in the same place.
Barachois pond	Where currents meet on a straight shoreline, spits formed may coalesce to form a triangular beach enclosing a small lagoon, or barachois pond.
Barrens	Rocky heathland supporting dwarf shrub and lichen vegetation (see H17).

Barrier beach	A stretch of sand dune which separates a coastal body of water from ocean waters in all but exceptionally high tides or during storms.
Batholith	A large intrusion of igneous rock, usually granite, with 40 sq. mi. (100 sq. km) or more, of surface exposure.
Bedrock	Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.
Benthos	Organisms living on, in, or attached to the seabottom. Includes both animals and plants.
Bioclimate	Small scale climatic situation generated by living organisms.
Bloom	Rapid growth of a population of planktonic organisms, usually, but not limited to, phytoplankton.
Boreal	Belonging to the northern geographic zone between the Arctic and Transitional zones.
Brackish	Salty water with a saline content less than that of seawater.
Bryophyte	A division of the plant kingdom which includes both mosses and liverworts.
Cambrian	The period which commenced at least 580 million years ago, and lasted until 500 million years ago.
Carboniferous	A period extending from 370 to 270 million years ago.
Catena	A group of closely associated soils within a given geographic region that originate from the same or similar parent material but that develop differing characteristics because of local variations in relief or drainage.
Climax forest	A forest whose composition is more or less stable and is in equilibrium with existing environmental conditions.
Colluvial deposit	Weathered material deposited by gravity - e.g. talus slope.

Community	An association of interacting populations, usually defined by the nature of their interaction with the place in which they live.
Cordilleran flora	Plants characteristic of boreal deciduous woods which are common on the Pacific coast or in the Rocky Mountains (see T16).
Cretaceous	The geological time period between 140 and 65 million years ago.
Crustacean	An invertebrate animal with at least five pairs of jointed legs, such as lobsters, copepods, amphipods and crabs.
Crustal plates	A series of major regions of the earth's crust which move relative to each other (see T2).
Cryoboreal	Colder parts of the boreal life zone (between the Arctic and transitional zones).
Crystalline rock	1. Rock consisting of minerals in an obviously crystalline state. 2. An inexact term for igneous and metamorphic rocks as opposed to sedimentary rocks.
Cupola	A small dome-like protrusion projecting from an igneous intrusion.
Detritus	Dead or decaying organic matter from decomposing plants and animals.
Devonian	The time period between 415 and 370 million years ago.
Diabase	An intrusive rock consisting mainly of labradorite and pyroxene.
Disjunct	An occurrence or population widely separated from the main geographic distribution.
Dome	A form of anticline which is inclined downwards in all directions.
Drowned estuary	An estuary which has become submerged under the sea by geological processes.
Drumlin	A smooth hill formed from deposits of glacial till (see T14), whose long axis parallels the direction of flow of the former glacier.

Dune	A mound, ridge or hill of windblown sand.
Dystrophic	Freshwaters of low productivity, acidic and strongly coloured by tannins and humic derivatives.
Echinoderms	The group of invertebrate animals which includes starfish, sea urchins, sand dollars and sea cucumbers.
Ecosystem	A system that explains the relationships within a particular assemblage of living organisms and the environment in which they live.
Ecotone	An area of transition from one habitat to another.
End moraine	Ridge-like accumulation of till built along any part of the terminal margin of a glacier.
Epifauna	Animals that live attached to or roving over the surface of the seabottom.
Erosion	The wearing away and removal of material on the earth's surface by forces such as running water, wave action, moving ice or winds.
Erratic	A large rock or boulder which has been transported some distance from its source, usually by glacial action.
Escarpment	A steep slope.
Esker	Long winding ridges of sand and gravel which originated within or beneath glacial ice (see T14).
Eutrophic lake	A productive lake, with a good supply of nutrients.
Fault	A fracture or zone of fractures in the earth's crust along which movement has taken place.
Felsite	A general term used to describe a light coloured igneous rock.
Formation	A mappable rock unit.
Fossiliferous	Containing fossils.
Fossils	Any evidence preserved in rock of a once-living organism.

Fragipan	A type of hardpan. It is a layer cemented by clay covering grains of silt.
Fungi	The group of plants characterized by a lack of chlorophyll and hence the inability to perform photosynthesis. It includes molds, mushrooms.
Glacial till	Nonsorted, nonstratified sediment carried or deposited by a glacier.
Glaciofluvial	Relating to streams fed by melting glaciers, or to the landforms produced by such streams.
Gleysols	Soils which are waterlogged for a significant portion of the year (see T32).
Graben	A steep-sided flat-bottomed valley formed between faults.
Granite	An intrusive rock consisting mainly of alkali feldspar and quartz. The term may be loosely used for any light-coloured, coarse-grained igneous rock.
Ground moraine	Rolling plain which has gently sloping swells, sags or basins composed of till.
Groundfish	Species of fish that feed on or near the seabottom.
Gypsum	One of the most common minerals of evaporites. A type of sedimentary rock.
Habitat	The natural home or environment of a plant or animal.
Hardpan	A layer of strongly cemented material occurring in unconsolidated sediments.
Herbaceous	Descriptive of non-woody plants with no above-ground persistent parts.
Hornfels	A type of metamorphic rock.
Hydric	Characterized by an abundant supply of moisture.
Hydrology	The study of water with reference to its occurrence and properties.

IBP Proposed ecological site	A reserve proposed by the Canadian Committee for the International Biological Program. An ecological reserve is a legally protected natural area where human influence is kept to a minimum. Its purpose is to preserve characteristic or regionally rare ecosystems.
Ice-plucked	A rock moved from its original site by the action of glacial ice.
Igneous rock	One of the three main groups of rock; igneous rocks characteristically appear crystalline, and were formed by the crystallization of magma.
Ignimbrites	Rock consolidated from volcanic material which was so hot when it was deposited that the fragments welded together.
Infauna	Benthic animals that burrow into the substrate.
Intertidal zone	The area between low and high tide marks. It is alternately covered by water and exposed to the air during each tidal cycle.
Intrusion	A body of igneous rock which has forced itself into pre-existing rocks.
Invertebrate	An animal which lacks a backbone.
Isopod	A group of crustaceans which includes woodlice.
Jurassic	The period in geological history between 210 and 140 million years ago.
Kame terrace	Material deposited at the side of a valley from melting water from a glacier flowing along the surface of the ice (see T14).
Kames	Steep-sided mounds of stratified material deposited against an ice-front (see T14).
Karst topography	A landscape typical of gypsum and limestone areas, where sinkholes have formed due to the dissolution of the rock by rainwater. Narrow crumbling ridges separate the sinkholes (see Unit 516).
Krummholz	A condition which trees growing in exposed areas may exhibit. The trees lean away from the direction of the prevailing wind, have one-sided crowns and do not attain their full height.

Lacustrine	Of lakes.
Leaching	The process by which the action of rain, and the substances dissolved in it, gradually breaks down and decomposes rocks. Materials may be removed from soil layers by leaching.
Lichen	A plant association consisting of a fungus living symbiotically with an alga.
Limestone	A bedded sedimentary deposit consisting chiefly of calcium carbonate.
Limnic	A term used to describe the environment of freshwater lakes.
Lithosphere	The silicate shell of the earth, including the mantle and crust.
Luvisols	Poorly drained acidic soils (see T32).
Marine transgression	The spread or advance of the sea over coastal land areas as a result of rising sea level or subsidence of the land.
Massif	A massive block of rock.
Mesic	Referring to habitats with plentiful rainfall and well-drained soils.
Mesophyte	A plant which grows in conditions of average water supply.
Mesozioc	The era of time between 247 and 65 million years ago.
Metamorphic rocks	Rocks whose physical and chemical properties were changed by elevated temperature and pressure at some point during their geological history.
Microclimate	The climate of a microhabitat.
Microhabitat	The particular parts of the habitat that an individual organism encounters in the course of its activities.
Microorganisms	Microscopic organisms, including animals, plants, bacteria, fungi etc., which are primarily single-celled, although some colonial forms and multi-celled organisms are included.

Minerotrophic	Descriptive of a habitat where nutrition (food chain) is based upon mineral nutrients.
Molluscs	The group of unsegmented invertebrate animals which possess an external or vestigial calcium carbonate shell. It includes clams, snails and squid.
Monadnock	An isolated hill which stands above the general level of a peneplain; they are erosion remnants of the original surface.
Mor	A well defined matted layer of organic deposits resting on mineral soil.
Moraine	Material deposited by a glacier, which has constructional topography independent of the surface on which the material lies.
Mull	A rich soil developed under mixed or hardwood forests where a reasonable supply of calcium is available.
Nutrient	Any substance required by organisms for normal growth and maintenance.
Oldfield	Abandoned farm land (see H18).
Oligochaetes	The group of annelid worms which includes the earthworm.
Oligotrophic	Lakes which have a poor nutrient supply and a low productivity.
Ordovician	The geological time period from 500 to 435 million years ago.
Orogeny	A period of mountain building, lasting tens of millions of years.
Ortstein	A type of hardpan. It consists of organic matter cemented with iron and aluminium oxides.
Outcrop	The area at which a particular rock unit is exposed at the surface.
Outwash deposit	A deposit of material laid down by streams flowing away from the front of a glacier.
Palaeoenvironment	The environment of the geologic past.

Pangea	A hypothetical supercontinent of past eras which was subsequently fragmented by continental drift (see T3).
Passerines	Perching birds.
Peat	A dark-brown or black organic material produced by the partial decomposition and disintegration of mosses, sedges and other plants which grow in marshes and wetlands.
Pelagic	Living or feeding in the water column as opposed to living associated with the seabed.
Peneplain	Smooth, rolling erosion surface that develops late in the cycle of erosion.
Perhumid (Climate)	A type of climate that has humidity values of +100 and above; wettest type of climate.
Permafrost	Permanently frozen ground.
Permian	The time period between 290 and 247 million years ago.
Physiography	The description and interpretation of land forms.
Phytoplankton	Plants of sea or lake which float or drift almost passively. Most are microscopic.
Pleistocene	A division of the Tertiary period of geological history during which glaciation occurred, ranging from 0.1 to 1.8 million years ago.
Pluton	A large-scale igneous intrusion.
Podzol	Soils formed in cool wet conditions; they have a strongly developed leached zone (see T32).
Polychaetes	Worms with true body segments and hard spines, mainly marine.
Precambrian	The period of time between the consolidation of the earth's crust and the beginning of the Cambrian period - about 4,000 million years in duration.
Primary production	The rate at which energy from light is absorbed and utilized with carbon dioxide in the production of organic matter in photosynthesis.

Productivity	Rate of production of new biomass by populations of organisms.
Provincial Park	A legally established park.
Quartzite	A granulose metamorphic rock consisting essentially of quartz.
Raised beach	A wave-cut platform which is now raised above the present sea level.
Refugium	A locality which has escaped drastic alteration following climatic change, in contrast to the region as a whole (plural-refugia).
Relict	An occurrence which represents localized remains of an originally much wider distribution.
Reserve	Crown land reserved for Park development.
Sandstone	A sedimentary rock composed predominantly of sand-sized quartz grains.
Scarp	A steep slope.
Sedimentary rock	One of the three main groups of rock. They are rocks formed from material derived from pre-existing rocks by processes such as weathering, erosion and precipitation.
Seepage site	A place where water oozes from the earth, often forming the source of a small trickling stream.
Shale	A laminated sediment composed predominantly of clay-sized particles.
Sill	A sheet-like body of igneous rock which conforms to bedrock or other structural planes.
Silurian	The period in geological history between 436 and 415 million years ago.
Slate	A fine-grained metamorphic rock easily split into flat, smooth plates.
Slumping	The formation of a landslide that develops where strong, resistant rocks overlie weak rocks.

Stratification	The presence of layers - or strata - in rocks.
Stratum	A layer of rock (plural - strata).
Striae	Small grooves on the surface of rock formed by glacial action.
Subaerial erosion	Erosion which occurs at or near the surface.
Succession	The progressive change in the composition of a community of organisms towards a largely stable climax.
Syncline	A fold in the layers of rock caused by deformation of the earth's crust. Synclines are basin-shaped and have the younger strata towards the centre of the fold.
Taiga	A boreal-tundra transition area, supporting windswept dwarf vegetation.
Talus (or scree)	Rock fragments resulting from the mechanical weathering of rocks.
Tectonic	Controlled by a process such as orogeny.
Tertiary	Of that period of time which elapsed between 65 and 36 million years ago.
Till	The glacial and fluvio-glacial deposits left after the retreat of glaciers and ice-sheets.
Topography	The description of the surface geographical features of a region.
Transition zone	An area linking two series of sediments formed in contrasting environments.
Triassic	The geological time period between 247 and 212 million years ago.
Tuff	Rocks consolidated from volcanic material containing a predominance of fragments not greater than 2 cm in diameter.
Tunicate	Primitive vertebrates; the adults are sessile and the larvae planktonic. They are also called sea-squirts.

Uplift plain	An eroded and levelled area of land which has been uplifted, therby forming a raised, generally uniform upland.
Upwelling	Vertical movement of water, usually near coasts and driven by onshore winds, that brings nutrients from the depths of the ocean to surface layers.
Volcanics	One of the main groups of rocks forming the earth's surface.
Wildlife	Any non-domesticated vertebrate animal.
Wisconsin glaciation	The last of four glacial stages in the Pleistocene of North America.
Xeric	Referring to habitats in which plant production is limited by availability of water.
Xerophyte	A plant which grows in a dry habitat and is able to withstand conditions of prolonged drought.
Zooplankton	The animal component of those organisms drifting or weakly swimming in the ocean, largely at the mercy of prevailing currents.

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    Group deposits 33 34 467 489 494 503 534 567 576 577 578 586 600 604 605 627
    Sea 31-33 577
Windsor Strata 634
Winter Moth 275 411
Wire Birch 85 441 513 523 550
Wire-grass 391 401
Wisconsin 635
    glaciation 68-71 261 453 466 579 631 675 723
    ice sheet 48 731
Witch Hazel 478
Witches Broom 201 240
Witherod 85 385 386
Wittenburg Ridge 534 535 567 577
Wolf 254 257 264
Wolffish 316

Wolfville Formation 37 44 642 647 656
Wolfville soil series 182 195 522 523 532 542 543 545 547 555
    559 561 661 669 698 701 709 713 715
Wood Fern 208 216 426 430 468
Wood Fern, Wood Sorrel association 426 431
Wood Frog 267 422
Wood Sorrel 216 426 430 431 468
Wood Turtle 268 269 368 369 580 721
Woodburne soil series 584 592 625 627 629 633
Woodchuck 255 259 650
Woodcock 393 518 650
Woodland Jumping Mouse 259
Woodpecker 237 242 417 422 469 473
    Black-backed Three-toed 433
Woodsia
    Alpine 472
    Rusty 84 396 472
    Smooth 84 472
Woodville soil series 649
Worms 378
Wyvern soil series 483 499

Xanthoria parietina 327
Xenolith 28 507

Yarmouth soil series 517 529 691
Yarrow 391 734
Yellow-bellied Sapsucker 237 436
Yellow-spotted Salamander 267
Yew 209
Yoldia 317

Zeolites 43
Zinc 34 54 56
Zirphaea crispata 328
Zonation 307 327-329 331 357 439 683
Zonitoides arboreus 272
Z. nitidus 384
Zoogenetes harpa 401
Zooplankton 323

NATURAL HISTORY of NOVA SCOTIA: THEME REGIONS

scale 1:500 000

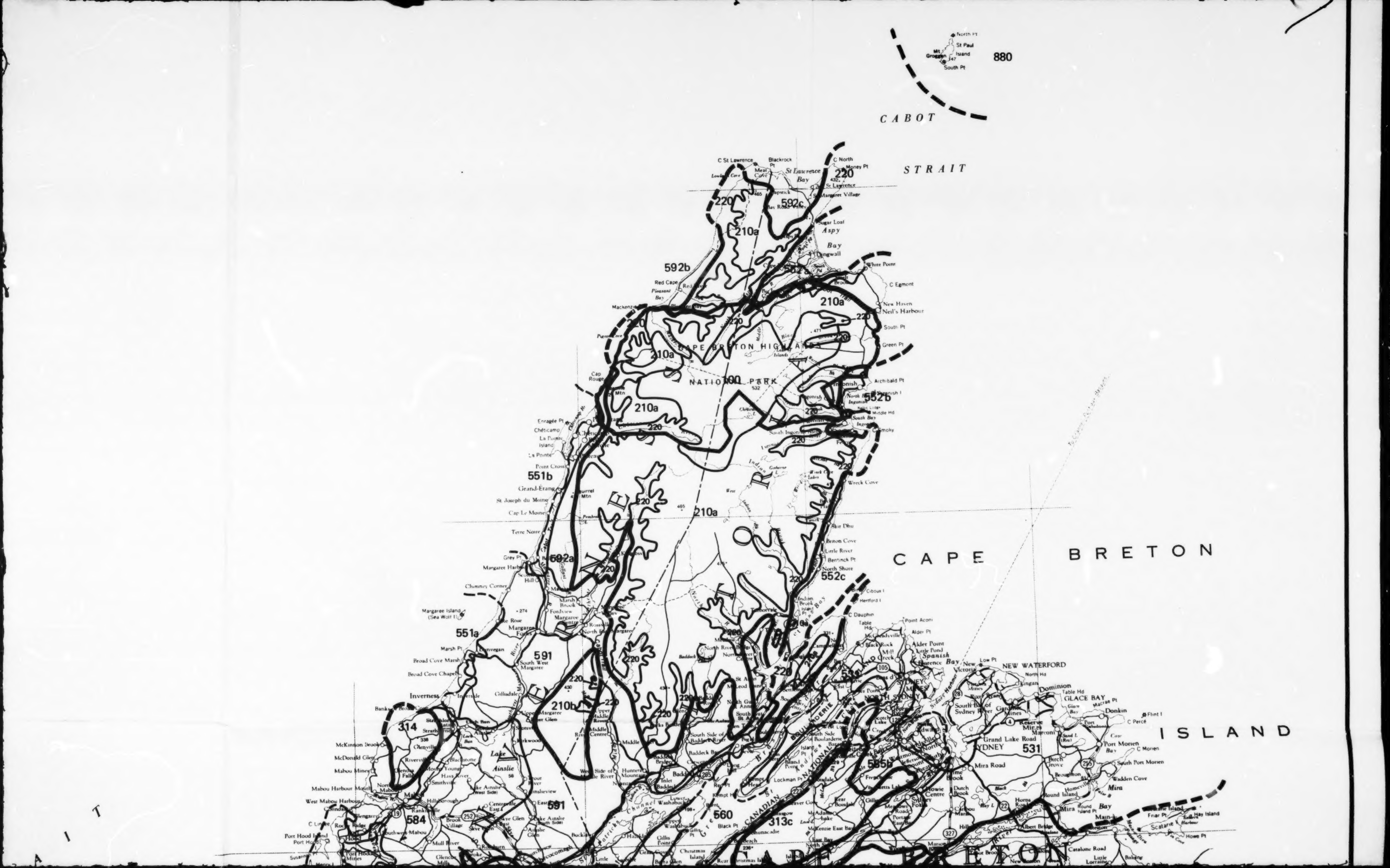
10
0
10
20
30
40 km

Topographical base derived from Map MCR 37,
Scale 1:500,000, Transverse Mercator Projection,
Central Meridian 63.
Department of Energy, Mines and Resources,
Surveys and Mapping Branch, Ottawa, Canada.

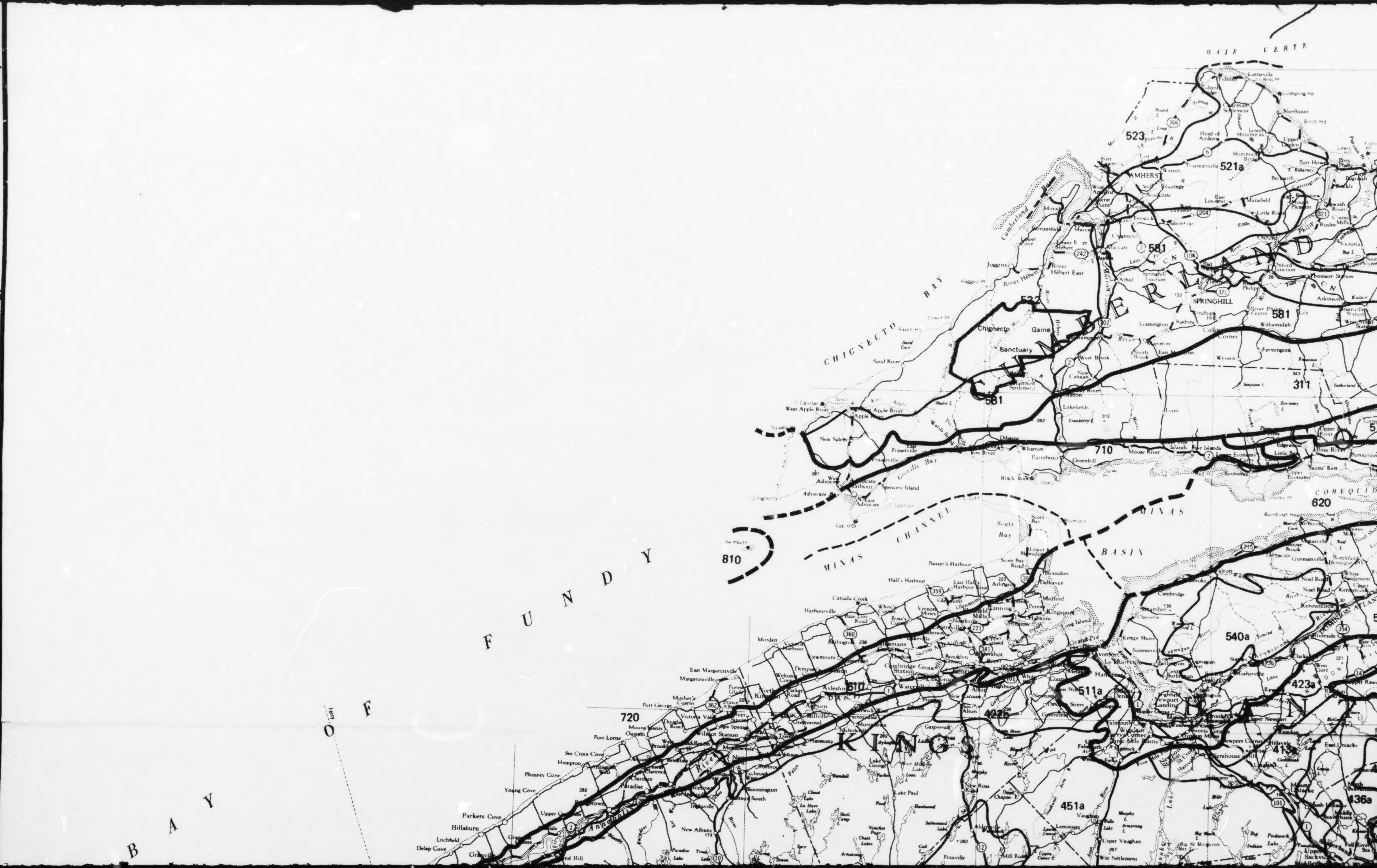
PREPARED FOR: PARKS AND RECREATION DIVISION
DEPARTMENT OF LANDS AND FORESTS
NOVA SCOTIA MUSEUM DEPARTMENT OF EDUCATION

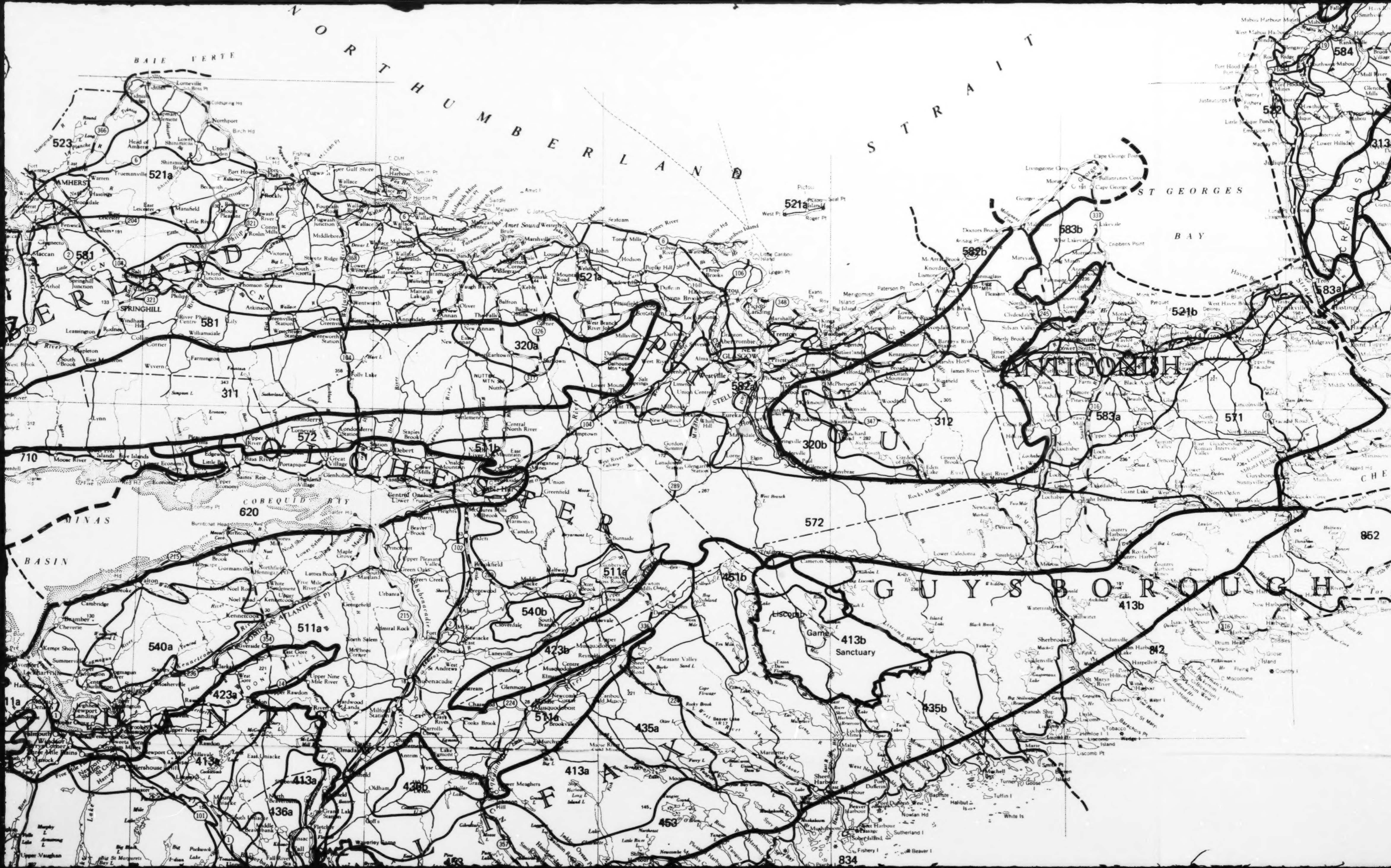
PREPARED BY: MARITIME RESOURCE MANAGEMENT SERVICE
AND GRIFFITHS–MUECKE ASSOCIATES
1984

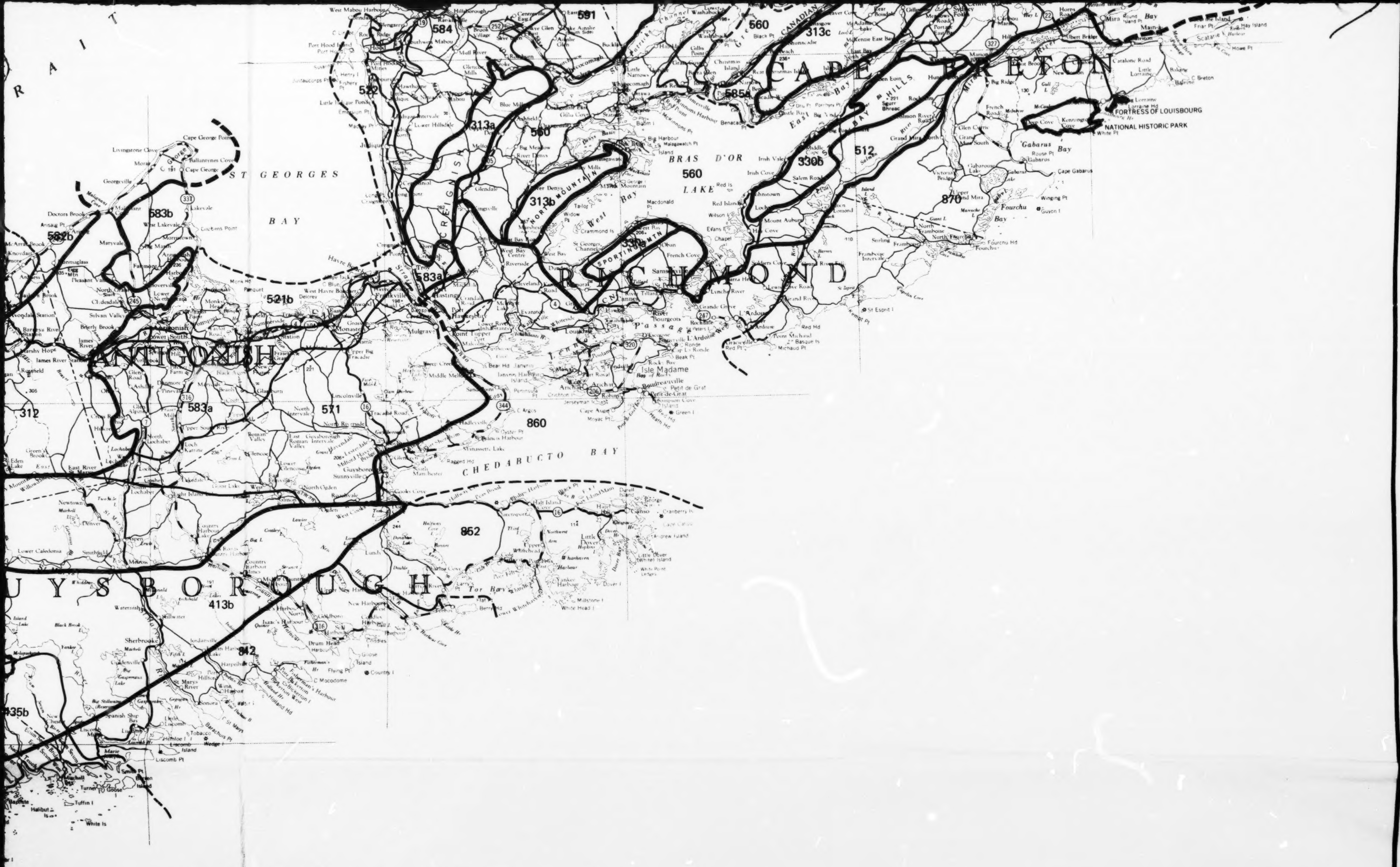
NORT
IT
BAIE VERTE
Margaree Island
(Sea Wolf I.)
551a
Marsh Pt
Broad Cove Marsh
Broad Cove Chapel
Inverness
Inverside
314
330
Glenville
McKinnon Brook
McDonald Glen
Mabou Mines
Riverville
Blackstone
Mount Young
Hays River
Smithville
North Mabou
Mabou Harbour Mouth
Mabou
West Mabou Harbour
Hillsborough
Colindale
Glengarry
Rankinville
19
584
252
Brook Village
C Linzee
Rocky Ridge
Southwest Mabou
Port Hood Island
Port Hood
Hood
Mull River
Susannah Pt
Port Hood Mines
Glencoe Mills



880
North Pt
St Paul Island
South Pt
CABOT
STRAIT
C St Lawrence
Blackrock Pt
St Lawrence Bay
C North
220
592c
220
210a
Aspy Bay
Dingwall
592b
Red Cape
Pleasant Bay
White Point
C Egmont
210a
New Haven
Neil's Harbour
South Pt
Green Pt
CAPE BRETON HIGHLANDS
NATIONAL PARK
210a
100
Cap Rouge
210a
220
Archibald Pt
552b
Enragée Pt
Chéticamp
La Pointe
551b
Point Cross
Grand-Étang
St Joseph du Moine
Cap Le Moine
Terre Noire
210a
Wreck Cove
CAPE
BRETON
Grey Pt
592a
Margaree Harbour
Chimney Corner
Margaree Island (Sea Wolf I)
551a
Marsh Pt
Broad Cove Marsh
Broad Cove Chapel
591
Inverness
210b
314
552c
Cape Dauphin
Point Aconi
Alder Point
Spanish Bay
New Victoria
NEW WATERFORD
Dominion
GLACE BAY
Table Hd
Donkin
Flint I
ISLAND
531
SYDNEY
585b
Mira Bay
Scatarie I
McKinnon Brook
McDonald Glen
Mabou Mines
Mabou Harbour Mouth
West Mabou Harbour
584
591
560
313c
Port Hood Island
Port Hood
Lake Ainslie
CAPE BRETON

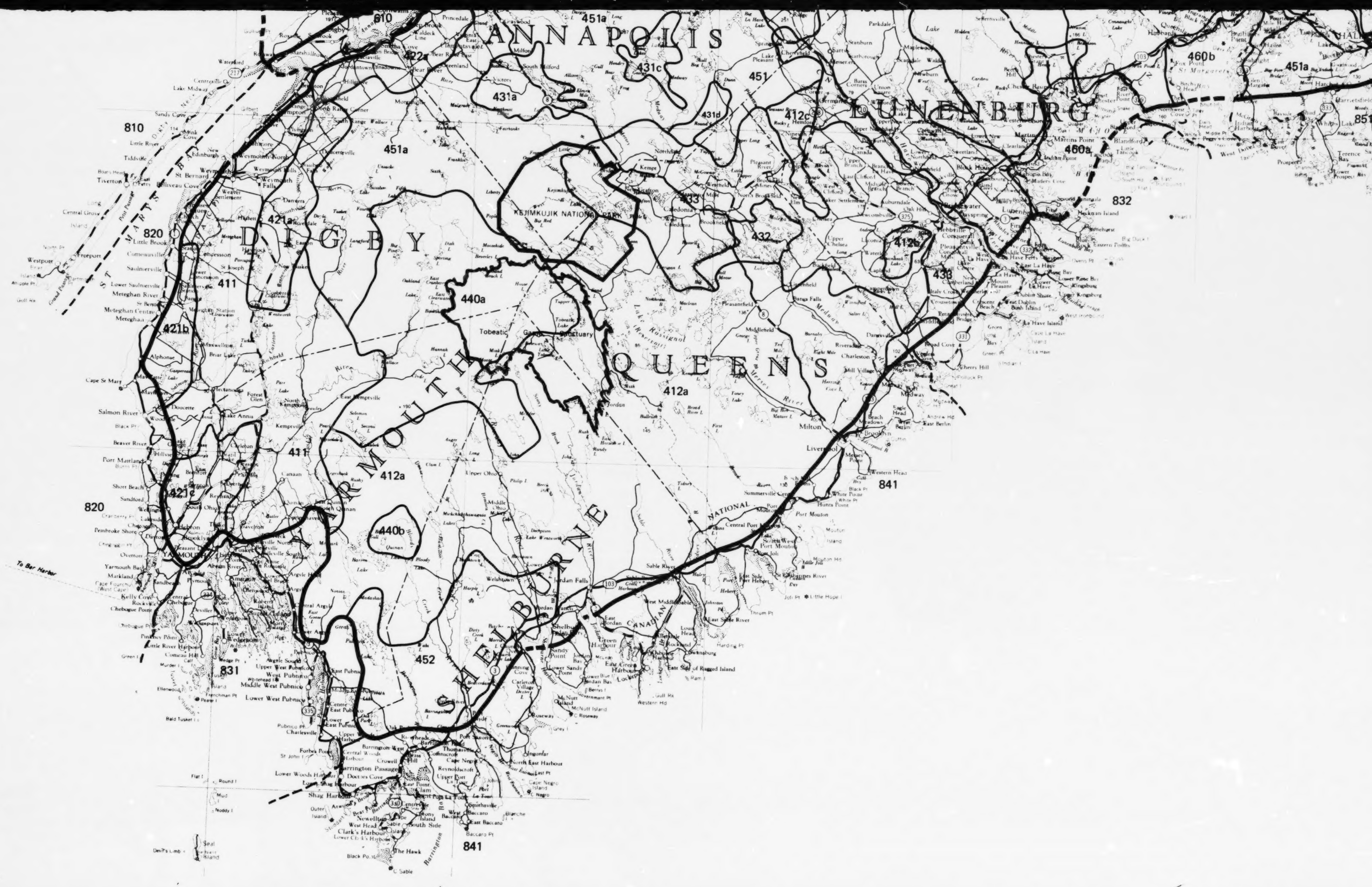

BAIE VERTE
523
521a
AMHERST
SPRINGHILL
581
311
CUMBERLAND
CHIGNECTO BAY
Chignecto Game Sanctuary
Parrsboro
710
620
COBEQUID
MINAS CHANNEL
MINAS BASIN
Scots Bay
810
BAY OF FUNDY
720
610
KINGS
540a
511a
423a
451a
413
436a
Windsor
Wolfville
Kentville
Berwick
Middleton
Annapolis River
Granville


NORTHUMBERLAND STRAIT
BAIE VERTE
ST GEORGES BAY
COBEQUID BAY
MINAS BASIN
CUMBERLAND
COLCHESTER
PICTOU
ANTIGONISH
GUYSBOROUGH
HANTS
HALIFAX
AMHERST
SPRINGHILL
NEW GLASGOW
Pictou
Stellarton
Westville
Trenton
Truro
Parrsboro
Pugwash
Tatamagouche
Wallace
Oxford
River John
Debert
Great Village
Londonderry
Economy
Five Islands
Shubenacadie
Stewiacke
Sherbrooke
Guysborough
Sheet Harbour
Liscomb
Game Sanctuary
Mulgrave
Judique
Port Hood
Mabou
Windsor
Hantsport
Kennetcook
Noel
Musquodoboit
Upper Musquodoboit
Middle Musquodoboit
Elmsdale
Enfield
Cape George
Malignant Cove
Arisaig
Merigomish
Tracadie
Havre Boucher
Pomquet
Caribou
Fox Harbour
Malagash
Earltown
Brookfield
Maitland
Walton
Cheverie
Chedabucto
523
521a
581
311
710
572
620
511b
320a
582a
320b
312
582b
583b
583a
521b
571
584
313
852
413b
842
435b
435a
413a
511a
540a
540b
511e
451b
423b
423a
436b
436a
453
834
Sanctuary
CN
DOMINION ATLANTIC (C P)



STRAIT
ST GEORGES BAY
CAPE BRETON
BRAS D'OR LAKE
NORTH MOUNTAIN
SPORTING MTN
EAST BAY HILLS
RICHMOND
ANTIGONISH
GUYSBOROUGH
CHEDABUCTO BAY
Gabarus Bay
Fourchu Bay
Tor Bay
Isle Madame
FORTRESS OF LOUISBOURG
NATIONAL HISTORIC PARK
Cape George
Antigonish
Port Hawkesbury
Mulgrave
Canso
Sherbrooke
Guysborough
Arichat
St Peters
Louisbourg
591
584
560
313c
585a
313a
313b
330a
330b
512
870
583b
582b
583a
521b
571
860
583a
312
852
413b
842
435b

Natural History of Nova Scotia


ANNAPOLIS
LUNENBURG
DIGBY
QUEENS
YARMOUTH
SHELBURNE
810
820
831
832
841
851
411
412a
412b
412c
421a
421b
421c
422a
431a
431c
431d
432
433
440a
440b
451
451a
452
460a
460b
KEJIMKUJIK NATIONAL PARK
Tobeatic
Game Sanctuary
Lake Rossignol (Reservoir)
Medway River
Mersey River
NATIONAL
CANADIAN
To Bar Harbor
Weymouth
Digby
Bear River
Annapolis Royal
Meteghan
Meteghan River
Saulnierville
Comeauville
Little Brook
Church Point
Weymouth North
Weymouth Mills
Weymouth Falls
New Edinburgh
St Bernard
Belliveau Cove
Alphonse
Brazil Lake
Salmon River
Beaver River
Port Maitland
Short Beach
Sandford
Pembroke Shore
Overton
Yarmouth
Yarmouth Bar
Markland
Kelly Cove
Chebogue Point
Pinkney Point
Little River Harbour
Comeau Hill
Wedgeport
Tusket
Argyle Head
Central Argyle
West Pubnico
Middle West Pubnico
Lower West Pubnico
East Pubnico
Centre East Pubnico
Lower East Pubnico
Pubnico Pt
Charlesville
Forbes Point
Lower Woods Harbour
Shag Harbour
Barrington
Barrington West
Barrington Passage
Doctors Cove
Newellton
West Head
Clark's Harbour
Lower Clark's Harbour
Black Point
The Hawk
C Sable
Cape Sable Island
Baccaro
East Baccaro
Baccaro Pt
Port La Tour
Smithsville
Port Saxon
Cape Negro
North East Harbour
Roseway
McNutt Island
Shelburne
Sandy Point
Lower Sandy Point
Jordan Falls
Jordan Bay
Lockeport
Green Harbour
Sable River
Port Mouton
South West Port Mouton
Summerville Centre
Hunts Point
White Point
Western Head
Liverpool
Brooklyn
Milton
Mill Village
Charleston
Port Medway
Cherry Hill
Broad Cove
Petite Riviere
Crescent Beach
La Have
Riverport
Lunenburg
Mahone Bay
Chester
Martins Point
Blandford
Bridgewater
New Germany
Caledonia
Kempt
Springfield
Middleton
East Kemptville
Kemptville
Carleton
Canaan
Upper Ohio
Welshtown
Cape St Mary
Westport
Freeport
Tiverton
Sandy Cove
Centreville
Waterford
Hubbards
St Margarets
Prospect
Terence Bay
Seal Island

460b
451a
851
833
832
DARTMOUTH
St Margarets
Fox Point
Hubbards
Blandford
Big Tancook Island
Prospect
Terence Bay
Portuguese Cove
Herring Cove
South East Passage
Cow Bay
Shut-in I
Devils I
Sambro I
Pennant Pt
Pearl I
Big Duck I

Theme Regions

100 PLATEAU-TAIGA

100 Plateau-Taiga

200 HIGHLANDS

210 Plateau-Fir Forest

- a) The Highlands
- b) Gairloch Mountain

220 Steep Slopes

300 AVALON UPLANDS

310 Hardwood Plateau

- 311 COBEQUID HILLS
- 312 PICTOU-ANTIGONISH HIGHLANDS
- 313 NORTH BRAS D'OR UPLANDS
  - a) Cregnish Hills
  - b) North Mountain
  - c) Boisdale Hills
- 314 MABOU HIGHLANDS

320 Dissected Margins

- a) Waughs River
- b) French River

330 Fault Ridges

- a) Sporting Mountain
- b) East Bay Hills

400 ATLANTIC INTERIOR

410 Quartzite Plains

- 411 SOUTH-WEST SCHISTS
- 412 MERSEY MEADOWS
  - a) Lake Rossignol
  - b) Leipsigate Lake
  - c) Rocky Lake
- 413 QUARTZITE BARRENS
  - a) Halifax
  - b) Guysborough

420 Slopes and Ridges

- 421 SISSIBO LOWLAND
  - a) Sissibo Lowland
  - b) Meteghan Lowland
  - c) Lake George
- 422 SOUTH MOUNTAIN SLOPE
  - a) Bear River
  - b) Gaspereau Valley
- 423 SLATE RIDGES
  - a) Rawdon Hills
  - b) Wittenberg Ridge

430 Drumlins

- 431 ANNAPOLIS DRUMLINS
  - a) Fisher Lake
  - b) Spectacle Lake
  - c) Alma Lake
  - d) Round Lake
- 432 PONHOOK DRUMLINS
- 433 KEJIMKUJIK DRUMLINS
- 434 LUNENBURG DRUMLINS
- 435 EASTERN SHORE DRUMLINS
  - a) Tangier River
  - b) Moser River
- 436 HEADWATER LAKES
  - a) Beaverbank
  - b) Dollar Lake

440 Granite Barrens

- a) Flintstone
- b) Bloody Lake

450 Granite

- 451 GRANITE UPLANDS
  - a) South Mountain
  - b) Ten Mile Stream
- 452 SHELBURNE GRANITE PLAIN
- 453 GRANITE RIDGE

460 Bays

- a) Mahone Bay
- b) St. Margaret's Bay

500 CARBONIFEROUS LOWLANDS

510 Till Plain

- 511 WINDSOR LOWLANDS
  - a) Shubenacadie River
  - b) East Mountain
- 512 SALMON RIVER LOWLAND

520 Coastal Plain

- 521 NORTHUMBERLAND PLAIN
  - a) Northumberland Strait
  - b) St. Georges Bay
- 522 JUDIQUE COASTAL LOWLAND
- 523 TANTRAMAR MARSHES

530 Stoney and Wet Plain

- 531 COAL FIELD
- 532 CHIGNECTO PLAINS

540 Clay Plain

- a) Cogmagun River
- b) Stewiacke Barrens

550 Coastal Fringe

- 551 INVERNESS COASTAL PLAIN
  - a) Inverness/St. Rose Coalfield
  - b) Cheticamp Coast
- 552 VICTORIA COASTAL PLAIN
  - a) Aspy River
  - b) Ingonish Beach
  - c) St. Anns Bay

Regions

100 PLATEAU-TAIGA

100 Plateau-Taiga

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  - a) Cregnish Hills
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  - a) Rawdon Hills
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- 431 ANNAPOLIS DRUMLINS
  - a) Fisher Lake
  - b) Spectacle Lake
  - c) Alma Lake
  - d) Round Lake
- 432 PONHOOK DRUMLINS
- 433 KEJIMKUJIK DRUMLINS
- 434 LUNENBURG DRUMLINS
- 435 EASTERN SHORE DRUMLINS
  - a) Tangier River
  - b) Moser River
- 436 HEADWATER LAKES
  - a) Beaverbank
  - b) Doller Lake

440 Granite Barrens

- a) Flintstone
- b) Bloody Lake

450 Granite

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  - a) South Mountain
  - b) Ten Mile Stream
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- 453 GRANITE RIDGE

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  - b) East Mountain
- 512 SALMON RIVER LOWLAND

520 Coastal Plain

- 521 NORTHUMBERLAND PLAIN
  - a) Northumberland Strait
  - b) St. Georges Bay
- 522 JUDIQUE COASTAL LOWLAND
- 523 TANTRAMAR MARSHES

530 Stoney and Wet Plain

- 531 COAL FIELD
- 532 CHIGNECTO PLAINS

540 Clay Plain

- a) Cogmagun River
- b) Stewiacke Barrens

550 Coastal Fringe

- 551 INVERNESS COASTAL PLAIN
  - a) Inverness/St. Rose Coalfield
  - b) Cheticamp Coast
- 552 VICTORIA COASTAL PLAIN
  - a) Aspy River
  - b) Ingonish Beach
  - c) St. Anns Bay

560 Submerged Lowland

570 Rolling Upland

- 571 MULGRAVE PLATEAU
- 572 ST. MARY'S BLOCK

580 Hills and Valleys

- 581 CUMBERLAND HILLS
- 582 PICTOU VALLEYS
  - a) Pictou River
  - b) McArras Brook
- 583 ANTIGONISH UPLANDS
  - a) South River
  - b) Lakevale
- 584 AINSLIE UPLANDS
- 585 IONA UPLANDS
  - a) Grand Narrows
  - b) Sydney River

590 Dissected Plateau

- 591 MARGAREE PLATEAU
- 592 ST. LAWRENCE SLOPES
  - a) Squirrel Mountain
  - b) Pollets Cove
  - c) Meat Cove

600 TRIASSIC LOWLANDS

610 Valley

620 Tidal Bay

700 FUNDY COAST

710 Basalt Headlands

720 Basalt Ridge

800 ATLANTIC COAST

810 Basalt Peninsula

820 Cliffs and Beaches

830 Beaches and Islands

- 831 TUSKET ISLANDS
- 832 LAHAVE DRUMLINS
- 833 EASTERN SHORE BEACHES
- 834 BAY OF ISLANDS

840 Quartzite Headlands

- 841 CAPES AND BAYS
- 842 GUYSBOROUGH HARBOURS

850 Granite Barrens

- 851 PENNANT BARRENS
- 852 CANSO BARRENS

860 Sedimentary Lowland

870 Till Plain

880 Cliffed Island

900 SABLE ISLAND

900 Sandy Island